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Science and Humanity

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TO COMPREHEND THE ROLE OF SCIENCE in American civilization, we must look beyond the scientist's desire for practical accomplishments. It is especially important that we understand this at a time when every man's life is profoundly affected by the scientist's actions and at a time when the national government has assumed a direct responsibility for training scientists with tax-contributed money.

The most powerful motive in science is curiosity. Few may doubt this, because curiosity is common to all men; it may seem unnecessary to comment further. I do so because, even in this age of science, curiosity is often considered a bothersome trait which has got us into a great deal of trouble from the days of the Garden of Eden to those of Hiroshima.

There is opposition to curiosity first in childhood. Only the most patient parent encourages its free development at the expense of his personal peace. Only the wisest of teachers discard the easy methods of didactic instruction to follow as counselors at the heels of students who freely satisfy their curiosity. Even in the scientific laboratory the student's curiosity is suppressed and the laboratory becomes a training ground for technical manipulation rather than a place for intellectual exploration. The present tendency to create an educational system which thus suppresses curiosity for the sake of "efficient" education robs modern civilization of the true scientists it needs.

Nor will the scientists' research flourish unless they have freedom to follow their curiosity. Against this there is now strong opposition. When science seemed rather unimportant, scientists were left pretty much alone to do as they wished—provided they were able to live. Nowadays science is recognized as necessary for human welfare and national survival. Because of this there are many who are willing to support science provided they can organize and direct the scientists' activities—about which they know but little. And there are those who believe that the usefulness of scientific research can be increased and its practical yield multiplied by putting many scientists to work under the controlled direction of a few.

There are problems and there are times which require that the individual freedom of the scientist be submerged in a common effort for the public good. But there is a grave danger that the present demand by publicists, industrialists, and public administrators for large scale scientific organizations may impede progress.

The most important discoveries of scientific research have come from the intellectual adventures of individual scientists. No one directed Newton to discover the laws of gravitation. No one organized Faraday's discoveries in electricity for the benefit of the modern electrical age. No one suggested to Roentgen that he discover X-rays for the diagnosis of human ills. No one instructed Niels Bohr to pave the way for atomic energy. Great scientific discoveries will usually elude direction and organization as surely as would the creation of great music or poetry, or sculpture or art. Much of scientific research is exploration of the unknown and I, for one, do not believe it is possible to direct the course of an explorer through unexplored territory.

Scientists have a second purpose, no weaker than curiosity, but more difficult to achieve. It is the desire to bring order out of chaos. Those who suddenly grasp the relation of previously unrelated facts, and thus see their relevance, experience a deep esthetic satisfaction. It is in that phase of scientific endeavor that facts and observations are formed into the structure of knowledge, which is the foundation for further discoveries. This is the role of the scientist's creative imagination. Without freedom and leisure for the play of his imagination, a scientist becomes only a fact-gatherer, dealing with the bare bones of science, unarticulated and unclothed with the flesh of meaning. As we plan our new age of science we shall do well to preserve an environment in which this freedom will be nurtured, despite the urgency of present needs. For it is unlikely that the scientists' imagination will often leap to a specified goal. A chaos of facts will seldom fall into an ordered, predetermined pattern, useful for a certain end.

Modern scientific endeavor must certainly be organized to provide the instruments for research and the combination of human skills necessary for diverse experimental tasks. But society will gain most from scientists if they are given freedom to observe, to experiment and think. Science is playing an important role in America's world-wide struggle for the freedom

of the individual. In order that science may play that role well, the freedom of the scientists must be preserved against the regimentation of overstuffed organizations here at home. Despite the fantasies of scientific planners in and out of Russia, I should be surer of the social value of a mere score of scientists who are free to investigate and explain the facts of nature than of a thousand who are organized for the solution of a directed end.

In a democracy, however, it is not easy to justify such personal leisure and freedom, when most of the population must labor at routine tasks. "Why," asked a member of a Congressional appropriations committee recently, "should so few be supported to learn so much when so many know so little?" It is well to admit to such skeptics that some of the most important contributions of science to human welfare have no obvious practical usefulness. But let them consider how in a few generations we have been freed from the fear of natural forces that were mysterious and malevolent; how we have been freed from slavery to ignorance and superstition. At a time when science is prized for its contributions of instruments and weapons, of food and health and physical power and comfort, I would remind you that the pleasure which comes from an understanding of the beauties and forces of nature is a subtle value of science which extends the horizons of our intellect and enriches our lives.

Scientists are largely to blame for the fact that these intangible rewards of scientific investigation are not generally understood. One never hears musicians or sculptors or poets justify their role in society with the claim that they increase the physical well-being of their fellow men. Society values them, insofar as it values them at all, for the pleasure they give to life. Scientists, however, emphasize the material benefits of science because these are readily comprehended and accepted. In doing so, they misrepresent and belittle some of their major contributions to human welfare. Scientific research is one of the great adventures of the human mind. When the spirit of that adventure is generally understood, it will quicken the life and raise the hopes of people everywhere.

This is sufficient justification for the support of science as a major activity in society. But the effects of science do not end there. There is scarcely an aspect of American civilization which has not been shaped by scientific research and the applications of research. Our supply of materials comes from the laboratory as well as from nature. Industry depends upon power, scientifically created and controlled. Commerce requires swift transportation. Men live in cities heated and lighted and kept sanitary by scientific methods. Accordingly, the maintenance of American society requires a great army of scientifically trained men and women.

The characteristics of a continually developing American civilization are such that there is also an ever-increasing need for scientific investigation. The discovery of new metals makes possible the design of new machines, but that may require the development of new mathematical procedures. Atomic energy has created new elements which have made possible the discovery of new treatments for disease. In turn, such treatments require new methods for human protection against radiation. Each new scientific development creates further problems which require more study and research.

The demands for the fruits of science are further augmented by the recent war and by the present international hazards. This is an old story in the modern tempo, for the practical importance of science to warfare has long been recognized. Galileo and Leonardo were employed by their governments to improve artillery and the art of fortification. From that time onward, science has shaped the pattern of warfare until today science is recognized as one of the first lines of national defense. Scientists are required by the thousands for the training and operation of our armed forces. New weapons of aggression, forged by science, require of scientists new means for counteraction and defense.

The New Status of Science

Our culture, shaped by science and dependent upon science for its preservation, is now changing the pattern and status of science in America. Of that new status there are four aspects worthy of consideration.

The support of research. The first is a great increase in the money spent for research. During the year 1930, 166 million dollars were expended for scientific investigation and for its development towards practical purposes. By the year 1947 this amount had been increased to more than one billion dollars, which does not include expenditures in the field of atomic energy. Looking into the future, the President's Scientific Research Board has recommended that the amount should be two and a quarter billion dollars by 1957.

It is significant to recite additional figures. In 1930 the United States Government expended 23 millions for science, or 14 percent of the total. In 1947 the federal sum was 625 millions, more than 50 percent of the total national expenditure for scientific research. Obviously, those who are responsible for determining our national policies believe that the support of science is a governmental function.

But it is not surprising that they should meet strong opposition. On the one hand, federal support of science is opposed because of fear that science and scientists will be deprived of their freedom, and that the fruits of science will wither. On the other hand, there is also fear that the central government may gain from its vassal scientists too much power over the American people. To shrink from such dangers, however, is to doubt the virtues of American democracy.

If there be any field of activity which is the proper province of the national government, it is the encouragement of research. It is from scientific research that our citizens have the greatest promise of higher standards of living, better health, and security against the dangers of foreign aggression. Individuals, unaided, cannot reap the full benefits of science.

It would be unfortunate if the full responsibility for the support of science were relegated to the government. The integration of science into American culture requires that many individuals have the status of participating stockholders in the advancement of science. That this is increasingly so is a healthy characteristic of our social customs. University departments of teaching and research are supported by great numbers of individuals who are conscious of their responsible part in society. Countless industries are this year expending half a billion dollars on the discovery and development of new knowledge. Foundations for the furtherance of research now receive the benefactions of millions who, to the limits of their resources, follow the generous example of the wealthy few. Such are the National Foundation for Infantile Paralysis and the American Cancer Society.

The need for more scientists. The wise use of these increased financial resources requires a great increase in the number of scientists. This is the second characteristic of the new status of science.

It is not long since scientific research was an avocation of teachers and exclusive occupation of but a few isolated workers. Today universities, industries, and the government compete to fill needs for many thousands of scientific investigators. The number of scientists, technicians, and engineers has increased only one-tenth as fast since 1940 as has the expenditure for research and development. While the budget was increasing 335 percent, the supply of trained manpower expanded only 35 percent.

The technological and scientific progress of the nation and its operation depend upon less than one-half of one percent of our population; one-tenth of one percent of our population are actually engaged in scientific research and development; less than twenty-five thousand among our population of 150 million have had the advanced training for scientific research and teaching represented by the doctorate.

To meet these needs, the universities are straining every available facility. Private and public foundations and industries are contributing large sums for the education of scientists, and the government is initiating fellowship programs for the training of young men and women. The Atomic Energy Commission alone has appropriated two and one-half million dollars for such fellowships during the coming year or two. This is the development of a national resource of great importance.

No individual is endowed with all the qualities required for the pursuit of science, but there are vast, untouched reservoirs of human talent. For the advancement of science, as for the advancement of every phase of our civilization, we must learn to identify and to train those who are best qualified for a given social function, without regard for family fortune. Only thus are we likely to meet the specialized needs of a complex culture.

The spread of science. For several centuries the universities have been the nurseries and the homes of science. Now, as the number of scientists trained in the universities increases, more and more of the scientists migrate elsewhere.

The university began to lose its place as the only home of research about 1900, when the laboratories of the General Electric Company and of the Bell Telephone system were first established. Such industrial laboratories have grown and multiplied without a stop in sight, and now they have their numerous federal counterparts. This spread of science outside the universities is a third characteristic of its modern pattern.

It is well for the universities that this is so. A university is the ideal environment for thought and investigation and the spread of knowledge. The application of that knowledge to the practical problems of today is the function of other institutions which are being created for that purpose. The university scientists who withstand the pressure to solve practical problems of the present are the scientists who are free to pave the way for useful applications of the future.

The social responsibility of the scientist. Many of those who are devoted to the discovery of new knowledge have developed a concern for its social effects. I would name this uneasy sense of responsibility as a fourth characteristic of modern American science. It is natural that this should be so in troubled times of great change, for which science is in no small part the cause.

The critical needs for national survival marshaled our science to an extraordinary degree during this recent war. But the scientists' satisfaction in their

achievements, which armed human courage, has been sobered by the realization that new forces of destruction were thus unleashed. Nor has the end of conflict been reassuring. The accomplishments of ages lie in ruins, and the hardly gained knowledge of nature is used by both, in the conflict between the good and the evil.

Science itself is neither good nor evil. It is "neither a benign nor a malignant activity of man." Science is a quest for knowledge and understanding, to be applied for human use as men desire. It is with such thoughts in mind that scientists feel an increasing obligation to participate in decisions as to how their discoveries and technical developments shall be used. But the fulfillment of this obligation will require scientists to acquire a knowledge of human affairs and of the motives which shape public policy. Even then scientists will most effectively participate in the wise use of science in public affairs by disseminating and understanding of science to those in public authority and to those who shape popular opinion.

Certainly it is desirable in a democracy that every citizen take an active part in the direction of government, to the limits of his abilities. Accordingly the growing social conscience of scientists is desirable. So, too, is the slowly increasing participation of scientists in the affairs of government. But our complex social structure requires that each citizen have a primary responsibility for some special task. Thus I return to the point that our future welfare requires that a goodly number of scientists be free to study nature without regard for the practical needs of the moment.

The Place of Basic Research

The encouragement of scientific exploration or research—in contrast with the application of science—has not always been a characteristic of American culture. Commenting upon this a century ago, Alexis de Tocqueville attributed the emphasis upon immediate, practical values to the traits of a democracy, where, said he, "men . . . seldom indulge in meditation . . . and require nothing of science but its special applications to the useful arts and the means of rendering life comfortable." The observations of this distinguished observer of democracy in America were not far wrong, for fundamental research has flourished less here than in Europe. But his assumptions as to the reason for our emphasis on the practical aspects of science have been disproved by the recent development of basic science within our democracy. There are significant causes for this increased emphasis on fundamental research.

One of these causes is the spread of college education and the inclusion of science in the academic curriculum. To this I would add adult education in science by the radio and by scientific journalism which has reached high standards here in the United States. But as President Conant has emphasized in his book *On Understanding Science*, much of our education still deals with the results of science; there is little discussion of the methods and sequence of science. Until this defect is corrected we face a popular demand that scientists mortgage their future usefulness by concentrating their efforts on the practical application of past discoveries.

Despite the inadequacies of scientific education for the layman, many recognize that Michael Faraday's discovery of electromagnetic induction was necessary for the subsequent development of electric power and light and traction; that the botanical research of Gregor Mendel in the garden of a monastery paved the way for increased production by modern agriculture; that the theories of Willard Gibbs laid the foundations for much of our chemical industry.

Realizing this dependence of the practical upon that which is at first impractical, many intelligent citizens have supported basic research in universities, whence the discoveries flow into the stream of knowledge. The universities have thus assumed responsibility for exploring the endless frontiers of the nation.

In a democracy, it is appropriate that this national service should have been initiated by individuals. It is desirable that they should continue to accept that obligation. But it is also a proper responsibility of the national government which previously has been charged with the development, and protection for the future, of basic natural resources such as forests, water power, soil, and fisheries. Basic research, in contrast to applied research and technology, is not unlike such resources, for it provides new scientific knowledge of future value for our national welfare. This is the reason for support of university research by the Public Health Service and the armed forces and the proposed National Science Foundation.

In accepting such a partnership with the federal government the universities have assumed an obligation to preserve the freedom of scientists to seek "new trails to knowledge." Despite the present vigor of science, many who determine public policies see the desirability of applying a new discovery in the development of materials, machines, or weapons, in the treatment of disease or in the improvement of agriculture. Few have the faith to support abstract research, in the exploration of the unknown, for the benefit of future generations.

"If the Americans had been alone in the world," said De Tocqueville, "with the freedom and knowledge acquired by their forefathers and with the passions

which are their own, they would not have been slow to discover that progress cannot long be made in the application of the sciences without cultivating the theory of them." We are not alone in the world, but we now occupy a position of preeminent power in world science. In our present position is it appropriate that we should benefit from the discoveries of scientists in other nations without contributing in return some discoveries to their benefit?

Science Is International

There can be no consideration of modern American science without regard to the international status of America. Our position in the world and the condition of the world depend upon science. If you suspect me of exaggeration, I suggest that you recall the influence of the atomic bomb on world thought and action.

The genesis of new ideas is catalyzed by the work and thought of others. Recognizing this, scientists have been among the first to realize the dependence of their work upon the efforts of those in other lands. Together with the traders for rare goods they have sought intellectual products and new discoveries wherever they were to be found. This desire for international cooperation derives from no unique nobility of spirit, but comes, rather, from the simple realization of the personal advantages that derive from a free exchange of ideas. If scientists are better prepared than others for the acceptance of the principles of world unity, it is because they have longer realized the benefits that come from such cooperation.

American scientists roam the free world for ideas and knowledge, and gladly receive their foreign colleagues who are free to come. Scientific missions to foreign capitals have been established for the exchange of information, and large sums have been allotted under the Fulbright Act for the interchange of scholars. Most significant, perhaps, is the role of the American government and American scientists in rebuilding the physical facilities for scientific research and teaching in foreign countries. Our nation is but one of the nations in a civilization that is based upon science. Lasting benefits of the unprecedented European Recovery Program will depend in large measure on the degree to which European science recovers its ability to meet the needs of a modern society.

Science increased in any free country will be "increased to the benefit of mankind in general." The observations of Galileo and Copernicus extended the intellectual horizons of no one national group; the discoveries of Faraday, the Englishman, have eased the labors of the citizens of many countries; a cure for disease discovered in Holland will be as beneficial to a sufferer in New York as it would be if it were made in Philadelphia. The future of American science and the welfare of the American people depend upon the rehabilitation of science throughout the world. Without such a scientific recovery, the civilization of other nations will become very different from the American culture.

Even now we delude ourselves when we talk of living in an age of science. The cultures of America and Western Europe are very different from those of other areas. If science expands in America without a corresponding development everywhere, there will be a further imbalance of cultures. There lies a grave danger to peace and stability.

The use of modern science gives a nation tremendous power and material advantages. Accordingly, it is natural in these days of international tension that those countries in which the practical aspects of science are developed to a high degree should be feared and suspected, and envied for the benefits they reap. This leads me to inject a comparison of American and Russian science. Excepting a few isolated, practical developments which would surely be used against us by an enemy, the discoveries of American scientists are free for all to hear and read. American scientists are encouraged to visit their colleagues overseas and to teach in foreign lands. Our laboratories and universities have been opened to foreign visitors coming by the thousands. Untold millions have been contributed to equip laboratories abroad. American science has done its part in rebuilding the international highways of science. This Russia has not done except in one week of self-gratifying celebration.

American science—in common with all phases of our culture—has accepted the responsibility to share its knowledge and its methods with all peoples, and especially with victims of poverty and disease and ignorance. Western science has an important role in shaping world cultures appropriate for these times.

Science Can Build A Better World

Modern cities with sanitation and communication and transportation are the products of science—but slums and noise and polluted air are symbols of our too great regard for the material aspects of civilization, and of too little regard for human life; the machine worker of mass production has not yet achieved a noble life of creation. Certainly the solution is not to abandon science, for even those who deplore most loudly the evils of our machine age would reluctantly return to a life of ceaseless labor, hardship, and disease. The same machines that build the slums can recreate the cities for human welfare. The planes that carried bombs on their missions of destruction

are also available for the swift transportation of sick and wounded.

If I were to name another and one of the most admirable characteristics of American culture, it would be the gradual union of the physical and the human sciences, and more especially the union of the natural sciences with the social sciences and the humanities. In these troubled days the scientists can take little satisfaction in the social consequence of their discoveries. The material contributions of science alone do not create a rich and satisfying life. Nor do the intellectual values of science alone provide the spiritual satisfaction which men crave. Scientists are merely partners of many others in mankind's great endeavor. Science liberates men from the fear of unknown natural forces, frees men from grinding toil for mere survival, subdues pain, and cures sickness. Thus, science frees men to enjoy art and music and literature and the beauties of nature and religious faith. Science makes possible the enjoyment of much that science alone cannot give. Scientists are partners of those in other walks of life who seek to improve man's estate.

I should be blind to the status of modern American science if I did not recognize its critics and opponents. Many are torn between *fear* of new horrors science may add and *hope* that science will build a better world. Without science, which created the atomic bomb, we would still be defenseless against natural forces and disease. Would we rather be the *certain* victims of natural forces or *possible* victims of atomic energy misused by man? The question is: Do we have courage to understand the facts of nature and educate our fellowmen to use them for human welfare?

Science provides the building stones of a better world—but the world will be as we choose to make it.

This article was condensed from a chapter in the forthcoming book Changing patterns in American civilization (*the inaugural series of Benjamin Franklin Lectures delivered at the University of Pennsylvania during the spring of 1948*). *The volume is to be published May 20 by the University of Pennsylvania Press.*

The Enzymatic Reduction of the Retinenes to the Vitamins A

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THE RETINENE$_1$, formed by the bleaching of rhodopsin, is converted to vitamin A_1 by a reaction for which reduced cozymase (DPN—H_2) serves as coenzyme (*10*). Retinene$_1$ is vitamin A_1 aldehyde (*2*); and the essential process is the transfer of two hydrogen atoms from DPN—H_2 to this molecule, reducing its carbonyl group to the primary alcohol group of vitamin A_1:

$$\underset{\text{retinene}_1}{C_{19}H_{27}CHO} + \text{DPN—}H_2 \xrightarrow{\text{retinene reductase}} \underset{\text{vitamin } A_1}{C_{19}H_{27}CH_2OH} + \text{DPN}$$

In the outer segments of the retinal rods this system is coupled with a second one which reduces DPN (*10*).

The reduction of retinene$_1$ has been followed in cell-free bries of whole retinas, in suspensions of isolated outer segments of rods (*10*), and in freshly prepared solutions of rhodopsin in aqueous digitonin (*3, 10*). Such fresh rhodopsin solutions lose the capacity to reduce retinene$_1$ within 3–4 hrs after preparation. This is because they lose their DPN—H_2 by the action of an enzyme widespread in animal tissues and particularly active in brain, to which retina is closely related (*4*). Rhodopsin solutions left at room temperature for 18 hrs, which have entirely lost the ability to reduce retinene$_1$, are reactivated by addition of new DPN—H_2. The apoenzyme, retinene reductase, is therefore relatively stable; the inactivation of fresh rhodopsin solutions is due to the loss of the coenzyme.

The retinene reductase system has now been fractionated into its components, all in true solution. Two components are in a satisfactory state of purity and chemical definition: the coenzyme, DPN—H_2, prepared by Ohlmeyer's method (*5*); and the substrate, synthetic retinene$_1$, prepared by the chromatographic oxidation of crystalline vitamin A_1 on manganese dioxide (*2, 8*).

The apoenzyme has not yet been isolated as a pure substance, but it has been prepared free of the other components. It is extracted with dilute salt solutions from homogenized frog or cattle retinas, forming a

[1] This investigation has been supported in part by a grant from the Medical Sciences Division of the Office of Naval Research. I should like to acknowledge the expert and devoted assistance of Mr. Paul K. Brown in many of the experiments.

lear, almost colorless solution. From this it is precipitated by half-saturation with ammonium sulfate nd may be redissolved without loss of activity. It an also be dialyzed in a Visking membrane for as ong as 18 hrs against M/15 phosphate buffer (pH 6.8; 5° C) without harm. It is destroyed by heating t 100° C within 30 sec. Its pH optimum lies at bout 6.5.

Retinene$_1$ is a typically fat-soluble substance and was originally introduced into our enzyme system with the aid of digitonin, with which it forms a water-soluble complex. This step proved to be unnecessary, however, since the retinal extracts which contain our apoenzyme take up retinene$_1$ directly. This in itself is evidence that retinene$_1$ couples with water-soluble substances from the retina. Primarily it attaches to protein, for it is precipitated from such solutions with the protein fraction.

It has been known for some time that in the product of bleaching rhodopsin *in solution*, retinene$_1$ remains loosely coupled with protein (*7*). In this condition it displays the properties of a pH indicator. Synthetic retinene$_1$ does not exhibit this behavior; nor does natural retinene$_1$ after adsorption and elution (*8*). Ball, *et al.* (*1*) have now shown that the pH indicator property is characteristic of retinene$_1$ in the coupled condition; synthetic retinene$_1$ acquires this property on condensing spontaneously with certain proteins, amino acids, and aromatic amines. Indeed, further evidence that the synthetic retinene$_1$ taken up by our apoenzyme solutions is coupled in this manner is that it has become a pH indicator. It has in fact taken on the properties generally associated with the product of bleaching rhodopsin in solution.

It is of some importance to note that retinene$_1$ is not restricted to a single complex in its retinal associations. Rhodopsin and retinene reductase are two distinct proteins. Retinene$_1$ normally originates on rhodopsin protein, but it must migrate onto the apoenzyme preparatory to its reduction. Such migrations of retinene$_1$ and changes of the molecules with which it is coupled must play an important part in retinal metabolism.

In the rods of fresh-water fishes, lampreys, and some amphibia, rhodopsin is replaced by porphyropsin (*9*). The bleaching of porphyropsin forms retinene$_2$. This is reduced to vitamin A$_2$ by an enzyme system entirely comparable with that which reduces retinene$_1$ in cattle and frogs.

This system may be assembled from the following components: the apoenzyme, contained in a saline extract of homogenized fresh-water fish retinas (sunfish, yellow perch); as coenzyme, DPN—H$_2$; and as substrate, synthetic retinene$_2$, prepared from vitamin A$_2$ by chromatographic oxidation on manganese dioxide (*8*).

The apoenzyme from fresh-water fishes, however, reduces retinene$_1$ as effectively as it does retinene$_2$. Conversely, the frog retinal apoenzyme reduces retinene$_2$ as well as retinene$_1$. There is no reason at this time to designate the apoenzyme differently in the rhodopsin and porphyropsin systems, since it is capable, in cooperation with DPN—H$_2$, of reducing either retinene to the corresponding vitamin A. It can be referred to simply as retinene reductase.

It was remarked above that retinal homogenates and extracts contain an enzyme which destroys DPN. In our fresh-water fish extracts this destructive action was so intense as to block the reduction of retinenes even when DPN—H$_2$ had been added. It is essential to protect the coenzyme in such preparations and it is advantageous to do so also in extracts of frog and cattle retinas.

Cozymase can be protected by adding nicotinamide to the enzyme system, in a final concentration of about 0.03 molar (*4*). It has been reported that α-tocopheryl phosphate (vitamin E phosphate; 0.0015 molar) similarly protects DPN (*6*). This last reagent has another beneficial effect on our system—as an antioxidant it inhibits the oxidation of the vitamins A formed as products of the reaction.

The retinene reductase system as most effectively assembled therefore reveals an extraordinary degree of vitamin interaction *in vitro*. The main process presents the novel phenomenon of one vitamin regenerating another, in that the DPN—H$_2$ which reduces the retinenes to the vitamins A, contains as its central component the antipellagra factor, nicotinamide, a member of the vitamin B complex. While so engaged, DPN—H$_2$ is protected from cleavage by the presence of free nicotinamide. The latter is aided in this action by vitamin E phosphate, which simultaneously protects the vitamins A formed in the main reaction from oxidative destruction.

A complete account of these experiments will appear in the *Journal of General Physiology*.

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TECHNICAL PAPERS

Sympathetic Ganglion Cells in Ventral Nerve Roots. Their Relation to Sympathectomy

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Surgical procedures designed to bring about sympathetic denervation of a part of the body have been based on the assumption that all peripheral sympathetic conduction pathways traverse the sympathetic trunks. If this assumption were correct, sympathetic trunk extirpation or section of the corresponding white communicating rami would result in interruption of all sympathetic pathways in the affected area, and insure its complete sympathetic denervation.

Failures to achieve complete sympathetic denervation, particularly of the extremities, by extirpation of the appropriate segments of the sympathetic trunks or by section of the white communicating rami in the appropriate segments have suggested the possible existence of peripheral sympathetic conduction pathways which do not traverse the sympathetic trunk. Such pathways could be postulated on the assumption that some embryonic nerve cells, in their displacement from the neural tube, have failed to reach the primordia of the sympathetic trunks and have been differentiated into ganglion cells in the ventral nerve roots, or adjacent to them, where they have become synaptically connected with preganglionic fibers which either do not extend into the sympathetic trunk or give off collaterals to the ganglion cells in question.

Small ganglia located in communicating rami in the lumbar (*1, 2, 7*), the cervical, and the upper thoracic segments (*5*) have been described. Most of them appear to be located in gray communicating rami. Occasional ones have been described as located adjacent to a ventral nerve root, probably in a white communicating ramus. Wrete (*7*) and Skoog (*5*) have suggested the possibility that such ganglia may be a factor in the residual activity following sympathectomy in some cases.

In examining a series of human bodies, we have observed small ganglia imbedded in ventral nerve roots or adjacent to them, usually at the site of origin of a white communicating ramus, particularly in the first and second thoracic and the first and second lumbar segments. Small ganglia have also been observed in communicating rami, particularly gray rami. In the present report only those in ventral nerve roots or adjacent to them will be considered. Most of them are small. Among the larger ones, an individual ganglion may comprise in excess of 20,000 ganglion cells. In appropriate histologic sections, fibers of the ventral nerve root may be traced into the ganglion. Fibers may also be traced distalward fr it in the spinal nerve. The possibility that the axon some ganglion cells in such ganglia extend into the sy pathetic trunk is not precluded, but most of them app to extend distalward in the spinal nerve without trav ing the sympathetic trunk. A nerve with sympathe ganglion cells located in its ventral root or adjacent to therefore, includes direct sympathetic conduction pa ways which are independent of the sympathetic tr and which, consequently, are not interrupted by extir tion of the corresponding sympathetic trunk or section the white communicating rami which join them.

The anatomic demonstration of sympathetic conducti pathways which involve synaptic connections in ventr nerve roots, and which do not traverse the sympathe trunk, affords a more satisfactory explanation than h been possible hitherto for most of the failures to achie complete sympathetic denervation by sympathectomy, i the absence of faulty operative technic. The frequen with which direct sympathetic pathways occur is indicat by the frequency with which residual sympathetic activi can be demonstrated following interruption of all th pathways which traverse the sympathetic trunk. In a extensive series of patients who had been subjected t extirpation of the sympathetic trunk from the eigh thoracic to the third lumbar segments inclusive, Ray an Console (*4*) demonstrated sympathetic activity, partic larly in the twelfth thoracic and the upper three lumb dermatomes, in every case.

Resection of the ventral roots of the second and thir thoracic nerves has been carried out, particularly b Smithwick (*6*), in preganglionic sympathectomies of th upper extremities. The advantage of this procedur probably depends on interruption of direct sympatheti pathways in which the ganglion cells are located in rel tion to the ventral root of the second thoracic nerve Since the ganglion cells associated with the ventral root of lumbar nerves appear to be located mainly in the firs and the second lumbar segments, section of the ventra roots of the first and second lumbar nerves, in additio to extirpation of the lower two thoracic and the uppe three lumbar segments of the sympathetic trunk, probabl would insure complete sympathetic denervation of the lower extremity in most cases.

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ctivation of Enzymes by Visible Light the Presence of Riboflavin

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During a study of the mechanism of light action on nt growth (*2, 3*) it was found that riboflavin can sitize the photo-oxidation of various indole-containing mpounds, including the plant growth hormone indol-tic acid and the amino acid tryptophane. Such pho-oxidations proceed rapidly at low concentrations of oflavin (0.1–10 γ/cc) and at moderate light intensi-s. Because tryptophane is normally present as a con-tuent of proteins, it seemed desirable to investigate e possibility that riboflavin could have a similar effect on the tryptophane of protein molecules.

For convenience in determining the effectiveness of our otoinactivation system we decided to use various en-me preparations as experimental proteins. In such periments we have invariably found that enzymes spended in riboflavin solutions are rapidly inactivated visible light. Thus urease is completely inactivated 2½ hr, α-amylase in 6 hr and tyrosinase in 17 hr. ince no enzyme which we have investigated has proved sensitive to this photoinactivation procedure, the phe-omenon seems to be quite general. In this paper, we hall report in some detail the results of our experiments ith the α-amylase of malt diastase.

The α-amylase investigated was present in Merck di-stase of malt. Preliminary investigations demonstrated hat the enzyme reacted most rapidly in the pH range .9–6.6. M/15 pH 6.1 phosphate buffer was therefore mployed as standard throughout these experiments.

The malt diastase was made up into a 1% stock solu-ion which was stored under toluene in the refrigerator. Such stock solutions were found to retain full activity for at least 1 week. Immediately prior to use, the en-zyme was diluted tenfold. For the study of the reaction, 1 cc of diluted enzyme was mixed with 4 cc of buffer and then with 5 cc of previously boiled 1% soluble starch. At desired time intervals, 1-cc aliquots of the reaction mixture were removed and added with vigorous stirring to 10 cc of $KI.I_2$ solution. The stock solution of this reagent was 2% KI, with enough resublimed iodine crystals added to give a distinct yellow color. The stock was diluted 1:100 immediately prior to use.

The blue color resulting from mixing the 1-cc aliquot of the reaction mixture with 10 cc of the 1:100 $KI.I_2$ was found to be quite stable and convenient to measure. All determinations of color intensity were made in a Klett-Summerson photoelectric colorimeter, using a red filter. Colorimeter readings at zero time were approximately 230; these readings fell linearly to zero in approximately 30 min at room temperature (23° C).

In order to compare the activities of control and experimental enzyme preparations, it was necessary to adopt some arbitrary unit of activity. For this purpose, we determined the time t necessary for complete disappearance of the starch color, and then expressed enzyme activity as $1/t$. In almost all cases, t was directly determined, but where partially inactivated enzymes were reacting very slowly, t was approximated by extrapolation.

To determine whether riboflavin could sensitize the photoinactivation of α-amylase, 1 cc of the diluted enzyme was mixed with 1 cc of pH 6.1 phosphate buffer either lacking (control) or containing (experimental) 100 γ of the riboflavin (Rbf). Tubes were either stored in the dark or were illuminated by 400 ft candles of fluorescent white light for 1 hr. At the end of this time, 3 cc of buffer and 5 cc of 1% soluble starch were added to each tube and aliquots removed for colorimetric analysis every 10 min. In order to insure that differences in activity would be due to the pretreatment of the enzyme and not to riboflavin effects on starch hydrolysis itself, riboflavin was incorporated into the buffer added to enzymes not previously so treated. The results of such an experiment are shown in Table 1. It is clear that visible light or riboflavin applied separately have but slight effect on the rate of enzyme action, but that illumination of enzyme solutions containing riboflavin result in a marked reduction of enzyme activity.

TABLE 1

EFFECT OF VISIBLE LIGHT ON ACTIVITY OF AN ENZYME SENSITIZED BY RIBOFLAVIN*

Contents during pretreatment	Illumination during pretreatment	Starch—$KI.I_2$ color after 10 min	20 min	30 min
1 cc enzyme 1 cc buffer	dark	118	64	9
1 cc enzyme 1 cc buffer containing 100 γ rbf.	"	134	71	12
1 cc enzyme 1 cc buffer	400 ft candle fluorescent white light	127	79	16
1 cc enzyme 1 cc buffer containing 100 γ rbf.	"	157	135	112

* Temp = 23° C, pretreatment period = 1 hr. After pretreatment, all tubes were made up to contain 1 cc enzyme, 3 cc buffer, 1 cc buffer-riboflavin and 5 cc 1% starch solution.

We next endeavored to arrive at some understanding of the nature and kinetics of the inactivation reaction. For this purpose a series of tubes was prepared in the dark room, necessary illumination for the operations being supplied by a 7½ W ruby-red bulb. Into each tube was placed 1 cc of enzyme and 1 cc of buffer containing 100 γ of riboflavin. The tubes were then carried into the laboratory and exposed to the light. At various intervals, tubes were removed from the light rack and returned to the dark room. At the end of 17 hr, all exposed tubes were tested for residual enzyme activity. To each was added 3 cc of buffer and 5 cc of 1% starch solution. Aliquots were then removed at frequent intervals, and the time, t, necessary for complete disappearance of the starch color was determined. Data are presented in Table 2. A plot of the log of relative en-

zyme activity against duration of preillumination yielded a straight line (Fig. 1). This indicates that the inactivation follows the time course expected for a first-order

TABLE 2

EFFECT OF DURATION OF ILLUMINATION ON ACTIVITY OF α-AMYLASE SENSITIZED BY RIBOFLAVIN

Duration of exposure to light	Time (t) in min to complete disappearance of starch	$\frac{1}{t}$	Relative activity
0	34	.0294	100
10 min	39	.0256	87
30 min	48	.0208	71
1 hr	66	.0152	52
2 hr	114	.0088	30
3 hr	220	.0045	15
4 hr	360	.0028	10
5 hr	582	.0017	4
17 hr	∞	0	0

reaction and probably involves a "one-hit" mechanism.

Subsequent experiments with antibodies and with bacteriophage have demonstrated that these types of proteins are also rapidly photoinactivated in the presence of riboflavin.

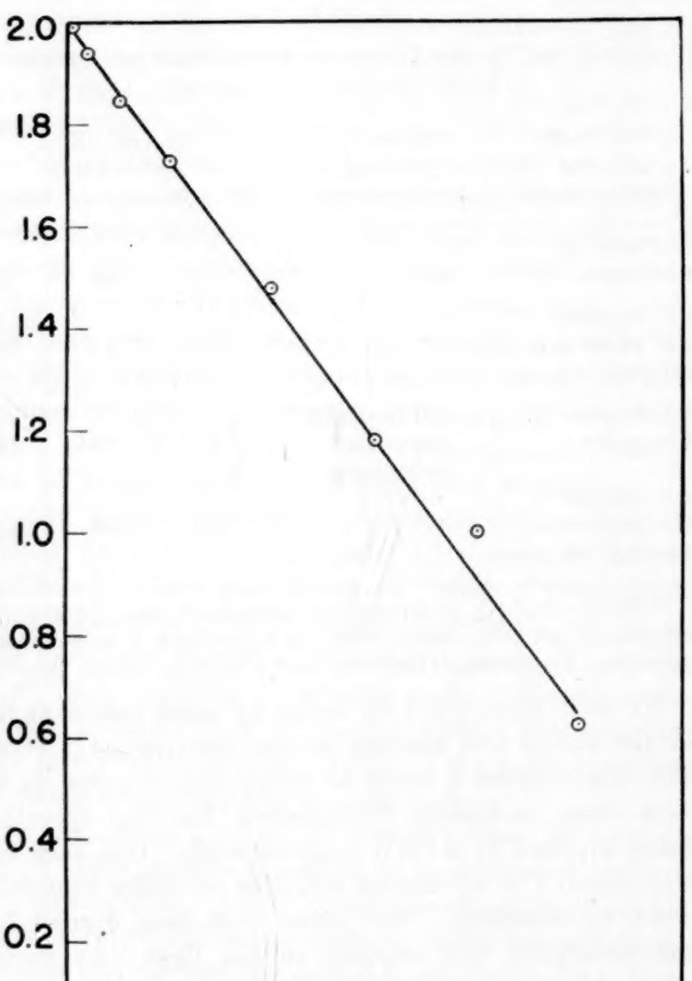

FIG. 1. Effect of duration of preillumination upon the inactivation of α-amylase.

As early as 1879 (*1*) it was reported that sunlight, especially the blue-violet wavelengths, could cause the aerobic photoinactivation of a crude enzyme preparation. Von Tappeiner (*6*) (see also other references in the review by Schomer [*5*]) later reported that the addition of fluorescent dyes such as eosin greatly accelerated such photoinactivation. It is perhaps not surprising, therefore, to find that riboflavin, which is strongly fluorescent in blue light, produces a similar effect.

Our investigations (unpublished) on the relation of light intensity and riboflavin concentration to the rate of photoinactivation strongly indicate that this type of reaction could proceed *in vivo*, at least in green plants. This reaction may therefore be of some importance in one or more of the light-growth reactions of plants such as phototropism, photoperiodism, and the light inhibition of internode growth.

It is also interesting to note that numerous investigators (*4*) have attributed the effects of ultraviolet irradiation of enzymes to a specific absorption by tryptophane. Since riboflavin is known (*3*) to cause the photoinactivation of tryptophane, this reaction may provide a mechanism whereby visible light produces the same sort of effect on enzymes as ultraviolet light.

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A New Method for Isolation and Purification of Mammalian Striated Myofibrils[1]

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The following method has been devised for isolating large numbers of mammalian skeletal and cardiac myofibrils in highly purified form without modifying their microscopic structure or reactivity to adenosine triphosphate.

The method with slight variations is suitable for isolation of myofibrils of man, rabbit, dog, and guinea pig. The present discussion is concerned principally with the isolation of skeletal myofibrils of rabbits and properties of the segregated fibrils.

A block (25 × 25 × 10 mm) of living white muscle from the anterior thigh was rapidly frozen and cut with a cold

[1] This research was aided by a grant from the Otho S. A. Sprague Memorial Fund.

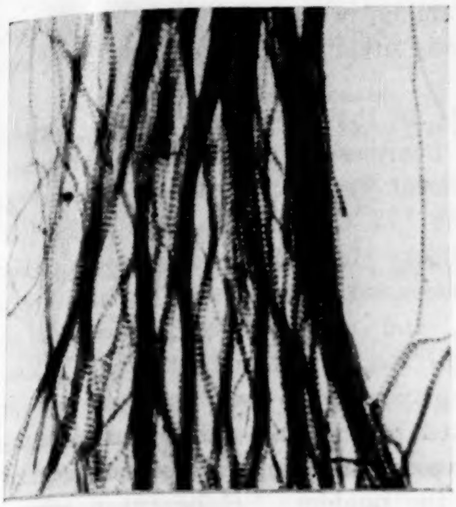

FIG. 1.

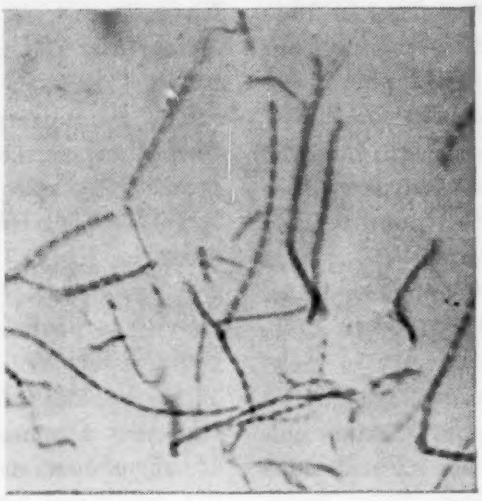

FIG. 2.

FIG. 3.

microtome into sections, 15 μ in thickness. The sections were transferred to 250 cc of potassium phosphate and citric acid buffer solution (pH 7, ionic strength 0.25, temperature 0° C) containing 5.0 cc of a 0.4% filtered solution of commercial trypsin. Sample sections were removed periodically, mounted under a cover slip and studied microscopically. When gentle pressure on the cover slip was sufficient to rupture the sarcolemma (Fig. 1) and permit the escape of segregated myofibrils (usually after 30–45 min of tryptic digestion), the sections were filtered from the enzyme buffer solution, washed, and resuspended in a potassium phosphate and citric acid buffer solution (pH 6.4, ionic strength 0.25). This suspension was agitated in a Waring blender for 5–10 sec. During this treatment the sarcolemma ruptured and myofibrils were released. This crude preparation was purified by repeated washing and centrifugation at 0° C. The final suspension of myofibrils formed a white flocculent mass containing only microscopic traces of collagenous and cellular debris. The myofibrils, usually single, but occasionally adherent in groups of two or more, were elongated, birefringent rods measuring 0.25–1.2 μ in diameter in fixed preparations. "A" and "I" disks were distinct but "Z" lines were rarely seen (Fig. 2).

The solubility of the myofibrils was studied microscopically. They promptly dissolved in 5–10 volumes of a cold aqueous alkaline solvent (0.5 M potassium chloride, 0.03 M sodium bicarbonate) yielding a viscous solution showing birefringence of flow. In cold buffer solutions (pH 1–12, ionic strength 0.15), the myofibrils dissolved in the ranges: pH 1–4, and pH 10–12.

The influence of ionic strength and potassium chloride on the solubility of myofibrils was determined by adding potassium chloride to cold phosphate and borate buffer solutions (pH 6–11, ionic strength 0.05). The myofibrils dissolved in solutions (ionic strength 0.2) alkaline to pH 10; in solutions (ionic strength 0.3) alkaline to pH 8; and in solutions (ionic strength 0.5) alkaline to pH 6. Comparable results were obtained with potassium phosphate buffer solutions of varying ionic strength and pH.

When isolated myofibrils under direct microscopic observation were immersed in a solution (0.075%) of adenosine diphosphate and triphosphate at room temperature, they spontaneously and rapidly contracted into small round masses. This contraction was not reversible (Fig. 3).

Paleocene and Eocene Strata in the Bearpaw Mountains, Montana[1]

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The dark, rounded features of the Bearpaw Mountains, rising some 4,500 ft above the surrounding plains in north central Montana, can be seen readily from railroad or highway between Chinook and Havre or between Havre and Big Sandy. Centennial Mountain, the most conspicuous land form in the western part of the mountains, has the appearance of a sleeping bear. This resemblance and the Indian legend associating the mountain with a prominent adjacent butte near Box Elder provided the original name "Mountain of the Bear's Paw." The softened contours of the Bearpaws are in large part the result of normal differential erosion of diverse rocks plus the effect of a forest mantle consisting of Douglas fir, ponderosa and lodgepole pines, cottonwood, aspen, white birch, service berry, cherry, hawthorn, rose, raspberry, alder, and dogwood—in brief, an outpost of the Rocky Mountain flora, 150 miles distant.

In this Bearpaw region irruptive magmas (now stocks, plugs, dikes, sills, laccoliths, flows, and agglomerate piles) in the Tertiary penetrated and at times overflowed a terrane originally of nearly horizontal sedimentary strata of late Mesozoic and early Tertiary age. These sedimentary formations exposed in and around the mountains are now tilted and faulted, with fault blocks of widely differing ages abutting against one another (7). The resulting complex geologic relations are unfortunately somewhat obscured in large areas by glacial deposits and bench gravel. The junior author began his geologic studies in 1937 with particular emphasis on the petrology

[1] Published by permission of the Director, U. S. Geological Survey.

of the mountains (*3, 4, 5*), but for a few days in 1940 and in the period August 13–22, 1948, the senior author joined in the field study of specific stratigraphic problems where paleobotanical experience was needed.

The identity of the coal-bearing strata several hundred feet stratigraphically above the marine Bearpaw shale (Cretaceous) in the southern part of the mountains has been subject to controversy for many years. These beds were identified in 1912 and 1914 as Fort Union by F. H. Knowlton for Pepperberg (*6*) and Bowen (*1*). In 1925, Reeves (*7*), on the basis of lithologic similarity to rocks of other regions with which he was familiar, designated the strata as Lance rather than Fort Union. In new collections recently made by the writers from carbonaceous shales and clays at the Ideal, Flatness, Blue Pony, Nygaard, Mackton, N L Ranch, and Nielsen Ranch coal mines and prospects are the following plants: *Glyptostrobus dakotensis, Sequoia* (*Metasequoia*) sp., *Cercidiphyllum arcticum, Aralia notata, Viburnum antiquum*, and *Viburnum asperum*. This is clearly a Fort Union (Paleocene) assemblage and supports the earlier conclusions of Knowlton and Bowen.

The Fort Union formation in the Bearpaw Mountains is characterized by brownish yellow sandstones and coal beds. The total thickness of the formation is not known but the portion exposed is in excess of 200 ft. The Judith River formation (Cretaceous), stratigraphically underlying the Bearpaw shale, also contains coal beds mined and prospected in the northern part of the mountains. The coal of the Judith River formation is, however, generally poorer in quality than that of the Fort Union formation. Associated carbonaceous shales and clays contain a diagnostic species of *Araucarites*. Several invertebrates also distinguish the Judith River formation.

Between the Fort Union formation and the Bearpaw shale is a coal-barren series of green-gray sandstones and thin shale beds. This section, in excess of 600 ft, is probably equivalent to the Fox Hills and Lance sequence that represents the uppermost Cretaceous sedimentation in this region.

Stratigraphically overlying the Fort Union formation, or faulted against it and older beds, is a sedimentary formation at least 450 ft thick, characterized in the basal part by a variegated sequence of sandstone and siliceous shale and in the upper part by sandstone and conglomerate. The dominant colors in the formation are red, purple, grayish yellow, and grayish green. A carbonaceous shale in the lower part of the formation yielded the floating fern *Salvinia preauriculata*, a diagnostic plant for the early Eocene in the Rocky Mountains and Plains region. The variegated beds yielded fragmentary remains of vertebrates (gar pike scales, turtles, and mammals). Of particular significance are a small, toothless, unidentified mammalian jaw and one somewhat worn molar tooth, identified by Dr. C. L. Gazin, of the U. S. National Museum, as resembling that of *Homogalax*, a tapirlike Eocene creature. Lithologically, the variegated sequence here assigned to the Wasatch formation, strikingly resembles the Wasatch in the Bighorn and Powder River Basins, Wyoming, where *Eohippus, Coryphodon, Diacodexis*, and many other Eocene mammals have been found.

The conglomerate in the upper part of the Wasatch formation in the Bearpaws represents boulder-channel deposits by streams of high gradient and is composed largely of quartzite like that of the Belt series (pre-Cambrian) in the Rocky Mountains. Other rocks present are limestone (Paleozoic), extrusive or intrusive porphyry, serpentine, and diorite-gabbro. None of the boulders is of local Bearpaw Mountain origin. Many of the boulders display pressure scars and accompanying fractures recemented by matrix sand, indicating effect of adjustment stresses attending or immediately following deposition of the boulders. Subsequent jointing of the indurated boulder bed produced secondary fractures in many of the boulders. Similarly bruised and fractured pebbles and boulders in conglomerate in Arizona were described by Campbell (*2*).

Uncomformably overlying the Wasatch formation in the southern Bearpaws are volcanic deposits of different compositions and ages. The oldest of these, principally latite, contains in the basal part tuffaceous beds that are plant-bearing. Remains of the following plants were identified: *Equisetum* sp., *Platanus* sp., *Aralia* sp., *Chaetoptelea* sp., *Laurus* sp., *Hydrangea* sp., and *Persea* sp. Some of the leaves are represented by only one fragment and consequently the species cannot be determined definitely at this writing. The general aspect of the assemblage, however, is that of other early or middle Eocene floras, in particular those of Yellowstone National Park and the Wind River Basin of Wyoming, but better collections may conceivably indicate a somewhat younger age.

The Eocene volcanic beds are of local Bearpaw Mountain origin. Their eruption was preceded by intrusions of monzonitic intrusive rocks and followed by a great variety of intrusive and extrusive igneous rocks, principally of alkalic affinity and presumably also of Eocene age.

It is evident that regional sedimentation in north central Montana continued into Eocene time, when it was interrupted locally by uplift and igneous activity. The Paleocene and Eocene formations, preserved in a few down-faulted blocks in the Bearpaw Mountains, were probably at one time continuous with formations of similar age now exposed in distant parts of Montana, Wyoming, and the Dakotas, the intervening portions having been removed by erosion. Thus, in the plains area of north central Montana, vertical fault displacements of about 2,000 ft preserved early Tertiary strata in downthrown blocks, and erosion in uplifted structures removed a stratigraphic section exceeding 5,000 ft in thickness.

In summary, the evidence here submitted establishes the existence in the Bearpaw Mountain region of coal-bearing strata of the Fort Union formation (Paleocene); of variegated and conglomeratic strata of the Wasatch formation (early Focene); and of volcanic rocks of probable middle Eocene age. The first settles an old controversy; the second reveals strata not hitherto reported

and dated; and the third restricts the probable date of the beginning of volcanic activity in the region.

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Sex Differences in Blood Pressure of Dogs

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There have been numerous reports in the literature dealing with blood pressure values in presumably normal men and women. Recently Boynton and Todd (*1*) reported blood pressure determinations on 75,258 students at the University of Minnesota—truly a formidable number. There were 43,800 men and 31,458 women in the various age groups studied. The mean systolic blood pressure for men and women of all ages was 122 and 111 mm of Hg respectively; the diastolic was 74.5 and 69.7 mm of Hg respectively. In every age group, save that over 40, the mean systolic pressure in men significantly exceeded that in women. Other workers have reported similar differences in blood pressure between the sexes, although a minority of authors believes that there is no significant difference.

It was thought worth while, from the standpoint of comparative physiology, to study the problem in the dog, to see if significant differences in blood pressure exist there between the sexes. It was deemed impracticable to determine the blood pressure in dogs by the indirect method, that is, by use of the inflated cuff. Therefore, 147 anesthetized dogs were used. Sodium barbital was the anesthetic chosen and was given either intravenously or intraperitoneally (300 mg/Kg). In the latter instance it was given 60 to 90 min prior to the blood pressure determinations. Under surgical anesthesia, a cannula was inserted into the carotid artery and the blood pressure recorded by means of a mercury manometer. After the normal blood pressure readings had been ascertained, these animals were used for other experimental purposes, before recovering from the surgical anesthesia.

Table 1 shows the results obtained. The male dogs had, on the average, a blood pressure of 9 mm Hg higher than that of the females. This difference is also reflected in the median values: 132 mm Hg for the males; and 124–125 for the females.

Tatum and Parsons (*3*) in 1922 called attention to the desirability of using barbital as an anesthetic agent for dogs, since it had the significant property of preserving an approximately normal blood pressure. As far as known,

TABLE 1

SEX DIFFERENCES IN BLOOD PRESSURE IN DOGS

Blood pressure range mm of Hg	Number of males	Number of females	Male average mm of Hg	Female average mm of Hg
60–79	0	1	...	60
80–99	3	6	91	92
100–119	12	24	111	110
120–139	28	24	129	128
140–159	14	23	150	147
160–179	9	2	165	166
180–199	1	0	190	....
60–199	67	80	134	125*
	Standard	Deviation :	21.5	20.7

* The difference (9 mm of Hg) between blood pressure for male and female dogs has a t value (according to Fisher) of 2.5803; for this value p is 0.011. The standard error of this difference is 3.50.

furthermore, the barbiturates have the same effect on male as on female dogs, in contradistinction to the action of some of them on male and female rats. Our results are not entirely comparable to those of Hamilton (*2*), who found no significant differences in blood pressure values between the sexes in street dogs. His method differed from ours, in that he used light doses of morphine sulfate and in that our experiments were performed on unselected dogs. It was impossible for us to control the age factor, except for the fact that only adult dogs were used.

It is to be concluded from our data that in adult barbitalized dogs, males have a significantly ($p = 0.011$) higher mean systemic blood pressure than females by 9 mm Hg.

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A Metabolism Cage for Small Animals

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The cage designed by Henriques and Hansen (*3*) for the quantitative collection of urine and described by them in 1904 has undergone numerous modifications. Some of these have simplified the form and increased the ruggedness (*1, 2*) while others have overcome specific problems in quantitative collection (*4*). The modification described below falls into the last category and was designed to isolate the feces so that subsequent specimens of urine could not contact them. The value of this adap-

tation is obvious when one wishes to analyze the urine for a compound which may be present also in the feces.

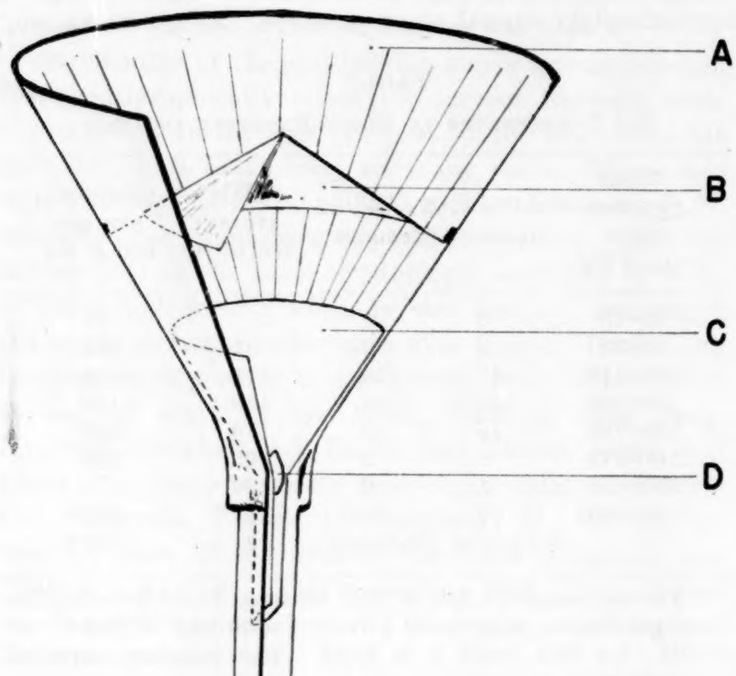

FIG. 1

The essential features of the new separating unit are shown in Figs. 1 and 2. A 3-in funnel (C) placed inside of a 10½-in ribbed funnel (A) collects the feces which either roll down the sides of (A) or hit the conical shield (B) and are deflected first to (A) and then to (C). The rim of the smaller funnel should be thin, approximately 1/32 in. A glass plug (D) prevents feces from entering the neck of funnel (C). Funnel (A) is a ribbed Mooney air vent model, preferred because of its small neck. Shield (B), detailed in Fig. 2,

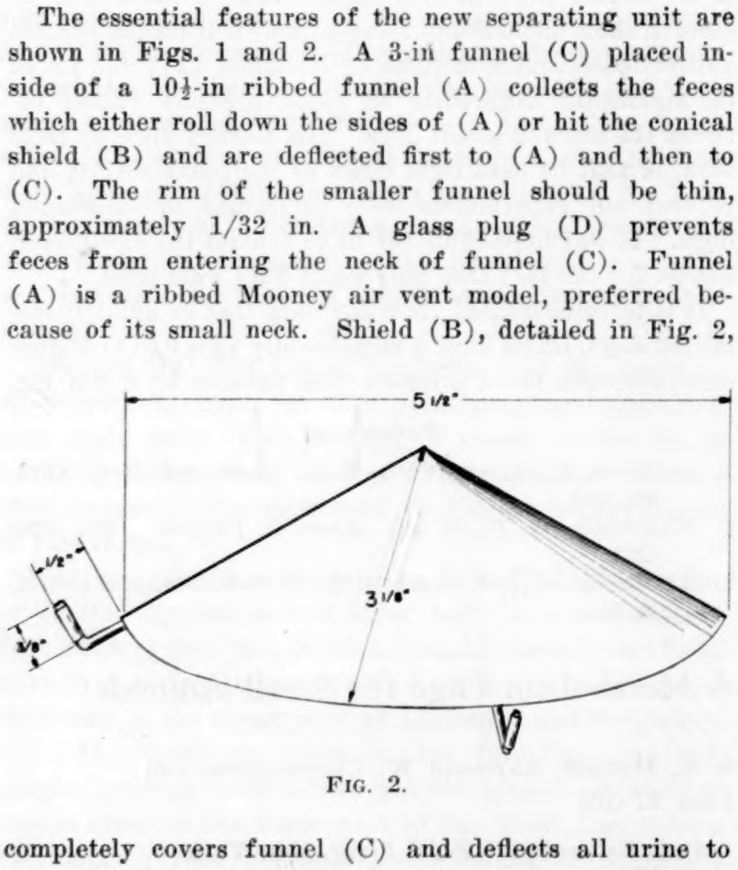

FIG. 2.

completely covers funnel (C) and deflects all urine to the surface of (A) where it runs between the funnels into a collecting graduate. This shield is a right circular cone with a slant height of 3⅛ in and a diameter of 5½ in at the base. It is supported by three rods 3/32 in in diameter and bent at such an angle that the terminal ⅜ in rests snugly on the sides of funnel (A). That portion of the rod which contacts the funnel is covered with rubber to prevent slipping. The cone is made of copper coated with tin and covered with a thin uniform layer of paraffin.

This assembly (Fig. 1) is supported by a 6-in iron ring anchored to a large ring stand. The animal is confined in a cylindrical cage 8½ in in diameter and 9 in high, made from ½-in wire mesh. This cage is anchored to the same stand by an L-shaped iron rod which supports it in funnel (A) so that its bottom is ½ in below the rim of the funnel and ½ in above the vertex of cone (B).

Twenty of these units have been in use for more than two years and satisfactorily accomplish the purpose for which they were designed.

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Penicillin in Relation to Acid Production in Milk by Starter Cultures Used in Cheddar Cheesemaking[1]

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The extensive use of penicillin in control of bovine mastitis has resulted in warnings to cheese factory milk producers (*1*) that sufficient penicillin may be carried over into the milk to interfere with normal development of acid by starter culture organisms when added to this milk in manufacturing Cheddar cheese. Slowness of acid production in the vat extends the time of manufacturing appreciably and results usually in low quality cheese.

The problem was studied by inoculating mixed or single strain starter cultures at the rate of 3% into pasteurized milk, dispensing 100-ml amounts into bottles, and adding a known amount of penicillin (ranging from 10,000 to 0.05 units) to each bottle. The bottles were incubated in a water bath at 98° F; 9-ml aliquots were removed at hourly intervals for titration with 0.1 N NaOH using phenolphthalein as indicator. Complete inhibition of acid production was obtained with 100 units, and virtually complete stoppage with 50 units penicillin per 100 ml milk. Partial inhibition was evident with 0.5–5.0 units in both the mixed and single strain starter series.

Penicillinase[2] when added at the rate of 0.02 mg per bottle completely canceled the effect of 5–10 units of penicillin and permitted appreciable acid production in the presence of 100 units of the antibiotic. The devel-

[1] Contribution No. 275.

[2] Kindly supplied by Miss E. Campbell, Laboratory of Hygiene, Department of National Health and Welfare, Ottawa, Canada.

opment of starter cultures composed of penicillin-resistant strains of lactic streptococci is another possible means of overcoming this difficulty. Cysteine did not do this even when added at the rate of 1–10 mg per bottle. Pasteurization of milk containing varying amounts of penicillin failed to inactivate the antibiotic.

Where occasional mastitis-infected animals are treated with penicillin this problem of inhibition of starter activity in the milk may not arise owing to dilution of the penicillin in the pooled milk supply. However, where extensive use of penicillin is being made, its inhibitory effect can be a source of considerable concern to the cheesemaker. Whitehead (*1*) suggests that milk obtained from cows during the 3-day penicillin treatment, and for one day thereafter, be used for purposes other than cheesemaking. The loss of this milk could be obviated most simply by addition of penicillinase.

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A Convenient and Rapid Method of Calibrating Warburg Manometers

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Although several methods have been described for the calibration of Warburg constant volume respirometers (*1, 2, 6*), it is generally agreed that calibration with mercury is the most reliable. Present descriptions (*1, 5, 7*) advise filling the inverted manometers through the neck from above, which is often cumbersome in practice due to the trapping of air bubbles in the column of mercury. We have recently used a variation of this method in which mercury is allowed to flow up into the manometer from below, thus avoiding this difficulty.

Using the method illustrated in Fig. 1, the time required for calibrating a manometer is reduced to less than 5 min. The only experimental value needed for calibration is the total volume (V) of the cup-manometer system, which for convenience is measured in two separate weighings. A scratch is placed on the neck of the manometer about halfway between the ground glass joint and the glass prongs that hold the fastening springs. The volume below this scratch will be referred to as V_C or the volume of the cup; while that above will be referred to as V_M, the volume of the manometer. The sum of V_C and V_M yields (V). Since the change in density of mercury between 20° and 28° is not significant in the determination of Warburg constants to two decimal places, these volumes are obtained simply by dividing the weight of mercury by 13.54.

Once (V) has been obtained, k_{O_2} and k_{CO_2} at 25° and at 37° may be read directly off the nomogram published by Dixon (*3, 4*) for the determination of Warburg manometer constants. For this, a hair line is stretched from the extreme left hand (V) scale across to the extreme right hand (v_F) scale, where v_F stands for the arbitrarily agreed on volume of fluid in the manometer cup.

For the convenience of workers unfamiliar with manometer calibration, the present method will be described

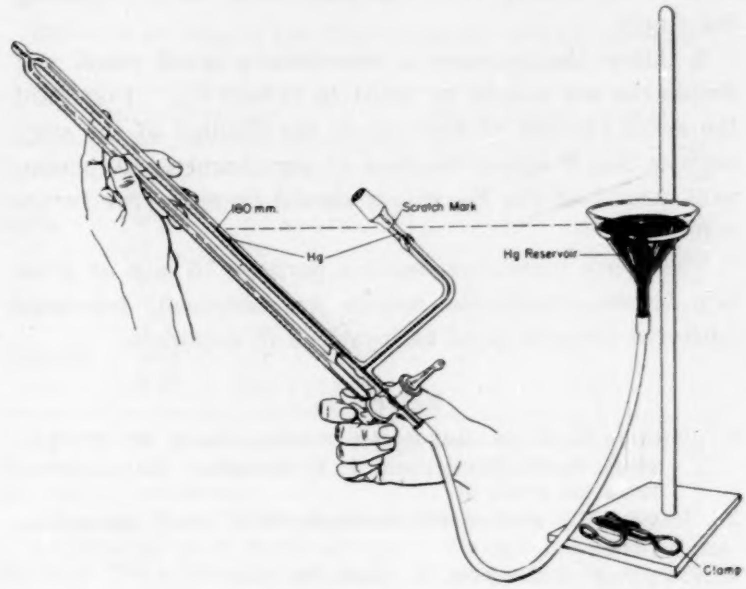

FIG. 1.

in detail. All weighings are made on a crude pan balance to the nearest tenth of a gram.

To obtain V_C:

1. Weigh the empty cup, stopper in place. Fill the cup completely with clean mercury, adjusting the level with a medicine dropper until the column of mercury just reaches the scratch mark when the cup is ground onto the manometer. Reweigh, and divide the net weight by 13.54 to obtain V_C.

To obtain V_M:

1. Attach a funnel to a ring stand as illustrated, and wire onto it a 3-ft piece of rubber tubing selected to fit snugly on the end of a manometer. Place a clamp on the end of the tubing and fill with about 100 ml of clean mercury.

2. Hold the inverted manometer above the level of the mercury reservoir and attach its lower end to the tubing. Remove the clamp and, slowly lowering the manometer, allow the mercury to flow evenly up into both the manometer limbs.

3. Leaving the mercury in free communication with the mercury in the reservoir, adjust the level of the mercury simultaneously in the two limbs until it just reaches the scratch mark on one side and the desired null point (180 mm for example) on the other. It is convenient to mark these two points with a thin red crayon for rapid identification.

The above adjustment is best done freehand with the elbows firmly planted on the table. The funnel should be adjusted to a convenient height depending on the operator. When the mercury columns are properly adjusted by combining the movements a) tipping the manometer, and b) raising and lowering it relative to the mercury in the funnel, the stopcock should be closed one-

eighth (not one-fourth) of a turn with the marking dot down.

4. Raise the whole manometer, keeping it slightly tilted, and turn the stopcock another eighth of a turn thus allowing air to enter the end of the stopcock and the excess mercury to flow back towards the reservoir. Detach the tubing from the manometer after replacing the clamp.

5. Allow the mercury to flow into a tared vessel and divide the net weight by 13.54 to obtain V_M. Disregard the small amount of mercury in the channel of the stopcock as this is below the level of significance. A permanent record of the V_M values should be made for future reference.

The above maneuver requires perhaps 15 min of practice before repeatable results are obtained, but once mastered permits rapid calibrations in duplicate.

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Effect of Radioactive Phosphorus (P^{32}) in the Culture Medium on Growth and Viability of *Phomopsis citri* and *Diplodia natalensis*

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Some interesting results were obtained while studying the effects of radioactive phosphorus on the physiology of *Phomopsis citri* and *Diplodia natalensis*, the fungi commonly causing stem-end decay in oranges.

Potato dextrose agar was prepared in two lots that were identical in every respect, except that one lot contained 20 ml per l of a solution of radioactive phosphorus. The radioactivity of the solution introduced into the agar ranged from 0.156 to 0.245 μc/ml, with a half-life of 14.3 days. The control lot of agar was treated with an equal amount of 0.1% solution of NaH_2PO_4. Mycelial tufts of the fungi were transferred from pure cultures to the center of the agar in Petri plates, and the daily rate of growth of the cultures was determined by measuring increase in diameter. During four replications of the experiment the P^{32} showed a tendency to retard the growth of *Diplodia natalensis*, whereas the results with *Phomopsis citri* were not very consistent.

When transfers of the organisms were made from the Petri plates to orange fruits, the fungi that had been grown on radioactive media were slower in producing decay than were the control lots. California oranges were selected for inoculation to avoid the possibility of natural infection in the fruits, since the two fungi under consideration are rarely found in oranges produced under irrigation. A total of 400 fruits were employed, 200 of each variety. There were four lots of 50 fruits in each experiment. Inoculations were made by removing the stem-buttons, cutting a slit in the exposed stem with a sterile scalpel, and then forcing some of the agar and mycelia into the slit. Navel oranges were inoculated with mycelia from cultures in which the P^{32} had shown definite inhibitory effects on the rate of growth of the two fungi. In the experiments in which Valencia oranges were used, the inoculum was taken from cultures in which no significant retardation of either fungus had been produced by the P^{32}. Tests were made with navel oranges in April and with Valencia oranges in November, so that each variety was inoculated near the end of its commercial season, when one would not expect much resistance on the part of the fruits to pathogens.

TABLE 1

Stem-end Decay in California Oranges Inoculated With Fungi Grown on Radioactive and Control Media

Variety	Days following inoculation	Percent showing decay					
		Phomopsis citri			*Diplodia natalensis*		
		Grown on radioactive media	Grown on control media	Chi square	Grown on radioactive media	Grown on control media	Chi square
Valencia	4	48	80	11.0	70	88	5.1
Washington navel	6	18	52	12.7	26	52	7.1

It will be noted in Table 1 that in all instances there was more decay in the oranges when inoculated with fungi from control media than when the inoculating organisms had been grown on radioactive media. The effect was not so pronounced with Valencia oranges as with the Washington navel variety. With the navels, the control fungi caused at least twice as much decay as did the fungi that had been cultured on radioactive media. However, the results in all instances were highly significant.

The ability of the fungi to cause decay was reduced by exposure to P^{32}, irrespective of whether or not growth of the organisms on culture media had been previously retarded. Furthermore, the radioactivity of the solutions employed was not great. The original solutions, with an activity of 0.156 to 0.245 μc/ml, were diluted 50 times in making up the culture media. At the time that the Petri plates were poured and inoculated, 1 ml of the agar emitted 10,000 to 11,000 counts per min. Inoculations were made into oranges a week or ten days later, and the amount of inoculum employed weighed approxi-

mately 20 mg. No radioactivity could be detected in the inoculum at the time that the oranges were inoculated. The delayed action of the fungi in infecting the fruits therefore appeared to be the result of previous exposure to P^{32} rather than to any actual radioactivity conveyed to the fruits in the inoculum. The very low activity of the original solutions suggests the possibility that greater dosages might be employed without too great an increase in health hazards.

It would be interesting to observe the effects of radioactive phosphorus on the subsequent decay of oranges, if the phosphorus were applied in the grove either as a spray or as a fertilizer. Although fungicidal sprays are employed in the groves, in commercial practice the most concerted efforts to control decay are made in the packing houses. However, control of stem-end decay of citrus fruits is made much more difficult because the two causal organisms become established in the stem tissues, and few fungicides will penetrate these tissues without injuring the fruits.

Progesterone in Blood Plasma of Cocks and Nonovulating Hens[1]

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Tests utilizing the method of Hooker and Forbes (*4*) have indicated the occurrence of progesterone in blood plasma of the regularly ovulating hens at least during certain phases of the ovulatory cycle (*3*). In extending these original observations, we thought it desirable to test raw plasma samples from males, and also from reproductively quiescent hens, as controls against possibly untoward reactions of the mouse endometrium to presumably progesterone-free plasma of avian origin. Preliminary tests unexpectedly yielded positive, and altogether typical, progesterone reactions. Additional assays confirmed these findings—the first direct evidence, so far as we are aware, of progesterone in the blood stream of normal males of any species.

The sex, breed, and age of the seven fowl furnishing plasma samples are recorded in Table 1, together with assay findings. Undiluted plasma (0.33 μg/ml) from the New Hampshire male did not give a positive reaction, possibly because of uterine distension or loss of material from the ligated segment. The questionable result from one of the females at the 1.0 μg/ml level may be accounted for similarly. All other findings are consistent among themselves; plasma from the two capons was completely negative at all levels tested.

The maximal levels of progesterone recorded in Table 1 are relatively high, ca. 3 μg/ml plasma, or about half the concentration most frequently encountered by Forbes and Hooker (*2*) and Hooker and Forbes (*5*) in mammals with active corpora lutea. The surmise that progesterone at these concentrations exercises some specific, if presently unknown, function seems reasonable.

TABLE 1

RESULTS OF ASSAYS FOR PROGESTERONE IN PLASMA FROM MALE, NONLAYING FEMALE, AND CASTRATED FOWL

Source of plasma			Progesterone, μg/ml*			
Sex	Breed†	Age	0.33	1.0	3.0	5.0
Male	W.L.	15 months	+	+	n.t.	n.t.
"	W.L.	16 "	+	+	+	–
"	N.H.	18 "	–	+	+	–
Female	W.L.	16 "	+	+	n.t.	n.t.
"	W.L.	16 "	+	±	+	±
Capon‡	N.H.	7 "	–	–	–	–
"	N.H.	ca. 4 years	–	–	–	–

* Plus and minus signs indicate presence and absence respectively of progesterone at indicated assay levels; n.t. no test at this level.

† Breeds: W.L., White Leghorn; N.H., New Hampshire.

‡ Castrated at 6 weeks of age. We are indebted to the Poultry Department, University of Maryland, for placing these capons at our disposal.

We cannot exclude the possibility that the substance in avian blood eliciting in the mammal the same reaction as progesterone may in fact not be progesterone. However, two of us (*6*) have recently completed tests of some 25 substances believed most likely to duplicate the action of progesterone; none of them did so in our tests. It is of especial relevance that testosterone and desoxycorticosterone acetate did not reproduce the effects of progesterone by the mouse assay (*4*).

Progesterone has been isolated from the adrenal glands of oxen (*1*), and pregnanediol concentrations in the urine of bulls are reported to exceed those normally found in the urine of pregnant cows, mares, or women (*7*). These and numerous other observations of an indirect nature have suggested that progesterone is not necessarily limited in occurrence to the female. The actual finding of progesterone in the blood stream of male fowl substantiates these views.

More extended investigations of avian and mammalian plasma from males, nonpregnant females, and castrates are currently in progress.

[1] This investigation was aided by grants from the Committee for Research in Problems of Sex, National Research Council, and from the James Hudson Brown Memorial Fund of the Yale University School of Medicine.

[2] Present address: Department of Anatomy, Emory University School of Medicine, Emory University, Georgia.

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Comments and Communications

Concerning a Dog's Word Comprehension

It is difficult to be sure of the extent that animals are able to generalize the meaning of those words to which they do definitely react. Data in this connection are as apt to come from spontaneous occurrences as from outright experiment.

To us the word *table* means something with a top, any kind of top, with four legs most frequently, any kind of legs, that is any size, any shape, and is used for a variety of purposes. Can a dog know *table* in that sense? Is a table anything but a special object with which the dog has special associations?

A woman who owns a large male English setter named Topper had given him a bone periodically. This always had occurred in the kitchen. Accompanying the act she always had said "Table, Topper," whereupon Topper had promptly carried the bone under the kitchen table. The woman, of course, had merely wanted to keep the rest of her kitchen floor clean. The table is a good-sized kitchen table.

Now one day there was a party in the living room. There were candy wrappers. Topper saw them and went to work on them. The woman immediately said: "Table Topper." She meant that he should take the papers into the kitchen under the table and chew them there. Instead, the dog seemed confused a moment, looked around, then deliberately walked to a small decorative coffee table, squeezed himself under it with difficulty, head far out in front, rump far out behind, and there confidently chewed. Plainly *table* in that dog's mind stood for something general, with at least two quite different examples. I invited the woman and her dog to my laboratory. I gave him a bone. At the woman's command he instantly went under a laboratory table. We tested him with all kinds of tables. The dog always went under the nearest table, never under the nearest chair or into a corner or a niche. Some weeks later the woman called me. She and the dog had been out in the large field back of their house, and the dog had dug up a buried bone. Almost idly, the woman had said: "Table, Topper." She had thought there was no table but she was wrong. At the end of the field, definitely out of sight, was an old picnic table that had been left there the previous summer. Topper knew about that table, and there he patiently carried the bone and munched.

To me it appears that the "Table, Topper" has become a stimulus for an action that includes the understanding of *table* as a fairly extended concept. In the last situation the dog has even laboriously searched out a table that he remembers and that the woman has forgotten. That is, this dog seems to understand the word with something approaching the spread of implications that it has for us.

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Interference with the Ultramicro Ascorbic Acid Method of Lowry, Lopez and Bessey

The ultramicro method of Lowry, *et al.* (*J. biol. Chem.*, 1945, **160**, 609) for the determination of ascorbic acid was used without special difficulty for nearly a year. Interference was subsequently encountered and since it may have been observed in other laboratories using this method, our experience with it and the means of avoiding it are herewith described. Interference was first encountered when an orange-red precipitate formed immediately after the addition of the dinitro-phenyl hydrazine reagent. This became progressively worse and occurred with blank, standard, and sample tubes alike. The precipitate dissolved only slightly upon addition of sulfuric acid and could not be completely removed by centrifugation. When it was possible to obtain a reading with the spectrophotometer on the reaction mixture, the values were high.

In an intensive effort to determine the cause of this precipitate, each of the reagents, including the distilled water, was systematically tested; the deep freeze storage unit was inspected for leaks of refrigerant; and other possible causative factors were sought. Finally, the cut-off ends of rubber sleeve stoppers, recommended by Lowry, *et al.* for sealing the micro tubes, were tested by extraction with 5% trichloroacetic acid, the protein precipitant used in the method. When this extract was added to the dinitro-phenyl hydrazine reagent, the characteristic precipitate formed immediately and consisted of the same needle-like crystals previously observed in the complete method.

A possible explanation for the failure of this interfering precipitate to develop when the method was first employed may be found in the fact that the rubber stoppers arrived with a protective coating. It was not entirely removed by the simple soap and water washing procedure. Perhaps the coating later wore off sufficiently to permit the liberation of some compound capable of reacting with the trichloroacetic acid and the dinitro-phenyl hydrazine reagent to produce the precipitate observed. Soaking the stoppers overnight in a 1N solution of sodium hydroxide in 80% alcohol, followed by thorough rinsing with distilled water, merely hastened the development of the precipitate.

The method is now successfully carried out by sealing each micro tube with a tiny oxygen-gas flame which closes it quickly without heating the tube contents or harming the ascorbic acid. Doubtless other satisfactory means of sealing these tubes can be found, but they should be tested first for possible interference with the reaction.

The chemical composition and properties of the precipitate are under investigation by one of us (R.R.S.)

at the Iowa State College Laboratories.

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Aerating Liquids by Agitating on a Mechanical Shaker

Kluyver and Perquin's *Schüttelkulturmethode (Biochem. Z.*, 1933, **266**, 68) has become a popular method of studying the physiology of molds. This method involves continuous agitation of submerged cultures on shaking machines and assures a more uniform supply of nutrients and oxygen to all cells as well as a more uniform removal of gaseous waste products than does the surface culture method. During studies on the metabolism of *Penicillium chrysogenum*, generously supported by the Bristol Laboratories, it became desirable to determine how much greater the potential supply of oxygen is in shaken media than in media kept stationary. Since certain media foam quite vigorously when shaken, the question of how seriously such foams interfere with the diffusion of oxygen also needed consideration.

Experiments to measure the rate at which oxygen diffuses into media would be most significant from a physiological point of view when performed with media that contain respiring cells. Unfortunately such experiments are also the most laborious to set up. For example, one could suspend varying amounts of cells in shake-flasks and observe the rate at which they take up oxygen. A graph of "volume of oxygen absorbed per unit time" plotted against "amount of cells" would indicate a direct proportion between the two until a further increase in cells no longer gave an increase in respiration. This would mean, provided that the supply of oxidizable substrate is adequate, that the rate of respiration has become so high that it is limited by the rate of oxygen diffusion into the medium. The rate of oxygen uptake corresponding to the horizontal portion of the curve would then be a measure of the rate at which oxygen diffuses into the medium. (Cf. Umbreit, Burris, and Stauffer. *Manometric techniques.* Minneapolis: Burgess, 1945, p. 9.)

One could, of course, determine the rate of diffusion more simply in the absence of respiring cells. These determinations unfortunately are subject to the criticism that any conclusions which they may suggest are not necessarily applicable to living systems. However, since at least preliminary information can be obtained in this manner, such determinations were made as follows: 150 ml of freshly boiled and rapidly cooled distilled water, sometimes containing added substances, were placed in 500-ml Erlenmeyer flasks, which were then plugged with cotton, and agitated at 28° C on a reciprocating shaker, having a 4-in stroke and shaking at a rate of 85 strokes per min. At zero time and at intervals thereafter, the amount of oxygen dissolved was determined by the Winkler method (American Public Health Association, *Standard methods for the examination of water and sewage*, New York, 1946). All determinations were made at least in duplicate.

Fig. 1 gives some typical absorption curves. Oxygen dissolved in agitated liquids very rapidly, nearly saturating the liquid within a few minutes. Diffusion into still water proceeded slowly, as expected. In all cases the rate of absorption was most rapid at the beginning of the experiment, and slowed down as saturation was being reached. Assuming the ideal case in which oxygen is used by the organisms as fast at it is furnished, one can estimate the potential oxygen supply from these high initial rates. For example, under our conditions oxygen diffused into shaken distilled water during the first 30 sec at a rate of about 30 ml of oxygen per hr per 150 ml of distilled water, which would theoretically support the growth of 1 g (dry weight) of cells having

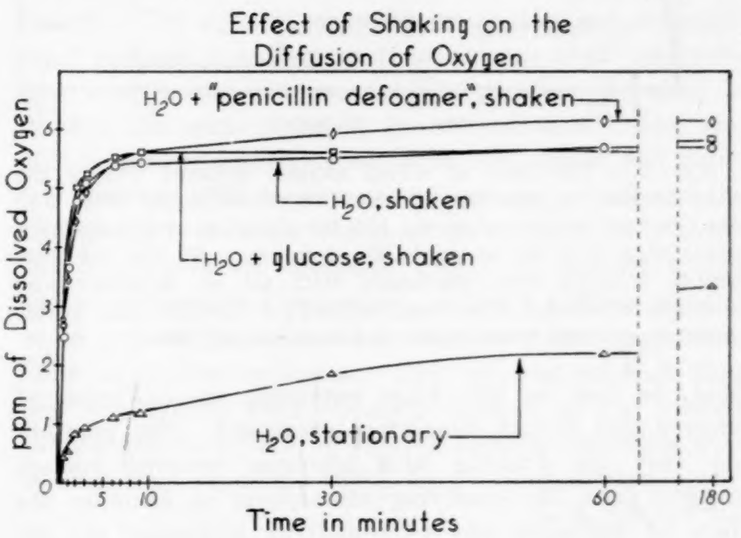

FIG. 1. The rate at which oxygen diffused during the first 30 sec, in ppm per hr per 150 ml of liquid was: 300 for shaken distilled water; 50 for stationary distilled water; 330 for shaken distilled water containing 0.05 ml penicillin defoamer; and 320 for distilled water containing 0.5% glucose.

a Q_{O_2} of about 30. This estimate is made with reservations, since the presence of high concentrations of nutrients and of cells will reduce the solubility of oxygen.

Not only did oxygen diffuse six times more rapidly into agitated water than into quiet water, but the total amount of oxygen present after 3 hr was 70% greater in the shaken than in the undisturbed water. Furthermore, it also seems likely that until the still water becomes completely saturated with oxygen there is an uneven distribution of oxygen; however, no determinations were made to test the validity of this assumption. The addition of 0.05 ml of Swift's "penicillin defoamer," an antifoam agent used in the manufacture of penicillin, did not appear to have a significant effect on the diffusion of oxygen; neither did the addition of 0.5% glucose.

It was at first difficult to find an artificial system that might be comparable to a medium covered by a foam, because the various foams tested in preliminary ex-

periments (such as beaten egg white, foams produced from solutions of corn steep liquor, Rinso, and Tide) either interfered with the Winkler method or were unstable. However, when nitrogen was bubbled from a Pyrex gas dispersion tube with fritted cylinder through a 2.5% solution of gum arabic, a thick foam developed which completely covered the solution and in spite of agitation stayed intact for about an hour. Fig. 2 shows

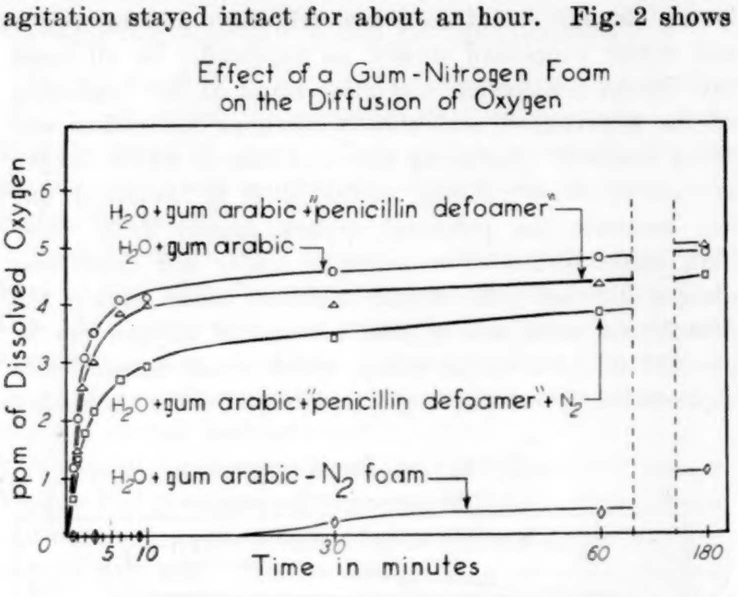

FIG. 2. The rate at which oxygen diffused during the first 30 sec, in ppm per hr per 150 ml of liquid was: 140 for the gum arabic solution; 150 for the gum arabic solution containing 0.05 ml of penicillin defoamer; 80 for the gum arabic solution that contained 0.05 ml of defoamer and through which nitrogen was bubbled; 0 for the gum arabic solution covered with a gum arabic-nitrogen foam.

that, as long as this foam persisted, the diffusion of oxygen was almost completely prevented. The possibility that the flushing with nitrogen removed enough oxygen from the overlying atmosphere to decrease the rate of diffusion was examined by repeating the experiment in the presence of 0.05 ml "penicillin defoamer." This antifoam agent prevented the foam, and diffusion proceeded at a fairly rapid rate. Flushing with nitrogen apparently did decrease the rate of diffusion somewhat, as can be seen from the absorption curve for the solution of gum arabic that contained the antifoam agent but through which no nitrogen was bubbled. The fact that oxygen diffused more slowly into the gum solution than into distilled water can probably be explained by an increase in the viscosity of the solution. Gum arabic did not interfere significantly with the Winkler titration. When gum concentration was increased in intervals of 0.5% from 0% to 3%, the diffusion rate decreased markedly while the titration blanks at zero time were about the same for all levels.

These results do not necessarily imply that the foaming that occurs during actual shake-flask fermentations interferes as seriously with aeration as did the gum arabic-nitrogen foam in our experiments. They do, however, draw attention to the need for further studies on the aeration of microbial cultures.

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Only Qualified Praise of Chisholm's "Social Responsibility"

George Brock Chisholm's article (*Science*, January 14, p. 27) received the unqualified approval of Rollin G. Myers in your March 11th Comments and Communications section (p. 264), and it appears justified to express in these pages some criticism on a basic point of Dr. Chisholm's philosophy since it is hoped that almost everybody in this country, at least, will agree with Dr. Chisholm's aims and efforts in general.

The point in question is Dr. Chisholm's concept of "original sin." Dr. Chisholm says "The uncomfortable fact is that very few people indeed can love themselves in a healthy natural way which tolerantly accepts all their own human urges as normal and inevitable aspects of the healthily functioning man or woman. Most of us, by being civilized too early or too forcibly, have been driven to believe that our natural human urges are 'bad,' 'not nice,' 'wicked,' 'sinful,' or whatever the local equivalent may be. . . . Unfortunately, the concept of 'sin' is, under one name or another, very firmly entrenched throughout much of the world."

It would seem that Dr. Chisholm is unfamiliar with the history of the Christian concept of "original sin" and particularly with the attitudes of such outstanding contemporary theologians as Reinhold Niebuhr and Paul Tillich. Suffice it to quote from R. Niebuhr's *Beyond tragedy, essays on the Christian interpretation of history* in condensation as follows: "Sin is not so much a consequence of natural impulses which in animal life do not lead to sin as of the freedom of reason by which man is able to throw nature out of joint and to make fateful decisions in human history. . . . Sin lies at the juncture of spirit and nature. . . . The most basic need of the human spirit is the need for security. . . . The primary insecurity of human life arises from its finiteness and weakness. . . . When man looks at himself he finds himself to be only one of many creatures in creation. But when he looks at the world he finds his own mind the focusing center of the whole. When man acts he confuses these two visions of himself. He knows that he ought to act as to assume only his rightful place in the harmony of the whole. But his actual action is always informed by the ambition to make himself the centre of the whole. . . . When thought gives place to action, self intrudes itself into every ideal. . . . His sin is to turn creatureliness into infinity . . . when he centers his life about one particular impulse . . . tempted by his peculiar situation of being a finite and physical creature and yet gifted to survey eternity."

It is exactly, then, the recognition of being sinful, the concept of the ever-present danger of deceiving himself, which ennobles man and which offers a hope of overcoming the great difficulties of present international human relationships.

OTTO E. GUTTENTAG

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Book Reviews

Physiology: vegetative physiology. (Part I.) (Fiat Review of German Science, 1939–1946.) Berlin, Germany: U. S. Army, Economics Division, Research Control Branch, APO 742, 1948. Pp. 224.

This review was organized by the Field Information Agencies Technical (FIAT) of the military government for Germany under the editorship of F. H. Rein. It covers, year by year, German literature on vegetative physiology and other literature on the subject with which the Germans were in contact for the years 1939 through 1946. The contents are "Further Developments of Physiological Methods," by H. Brünner, "Physiology of the Gaseous Components of the Blood," by E. Opitz, "Physiology of Blood Coagulation," by E. Wöhlisch, "The Peripheral Circulation," by M. Schneider, "Physiology of the Heart," by K. Kramer, and "Electrocardiography," by E. Schütz. All of the authors have covered their subjects well.

It is not easy to summarize a review which refers to half a dozen papers on nearly every page. The section on methods deals particularly with electrical methods, including electrical manometers and technics for gas analysis. Among these is an "oxygen sound," by which a lamp and photocell can be introduced into the heart in animals to measure oxygen content of mixed venous blood *in situ*. The second deals with arteriovenous oxygen differences in different organs; that of pure muscle blood is high during rest (30 to 70%) and very high in maximal work (over 90%). References are made to the German Himalayan expedition reports. The section on blood coagulation should be valuable to those working in this complex field. The fourth section gives attention to Rein's work on the subordination of chemical and nervous vasoconstrictor mechanisms to local effects during activity. The fifth section discusses the control of the intact heart as compared with the isolated heart, and Rein's theory of interrelations between liver and heart metabolism. "Electrocardiography" is not amenable to analysis.

The review refers to many other papers of importance which could not possibly be listed here.

H. C. Bazett

University of Pennsylvania

Biochemical evolution. Marcel Florkin. (Edited, translated and augmented by Sergius Morgulis.) New York: Academic Press, 1949. Pp. vi + 157. (Illustrated.) $4.00.

This short monograph fails to achieve the author's purpose as stated in his foreword. In the translator's preface it is suggested that "Some may object that the title is overambitious . . . and beyond the true measure of the book's scope." The reviewer does object and not only because, as suggested by the translator, "it deals with only half of the biological world." A major part of the book is devoted to a secondary purpose, i.e., to showing that a biochemical classification of animals does not differ from the taxonomy of morphologists. That a static classification of the animal kingdom, either biochemical or morphological, supports the common conception of evolution as a dynamic and continuing aspect of life is at least a debatable point. Approximately one-fourth of the text describes examples of so-called biochemical adaptations. The pitfalls encountered in considering adaptions as a factor in the evolutionary process are too well known to be emphasized. In the extreme analysis life itself could be cited as an adaption. The contribution of modern genetics to our understanding of evolution is barely mentioned.

The volume is well bound and the typography is excellent. The style of presentation is dull and uninspiring; perhaps it suffers in translation. Both biologists and biochemists will encounter a peculiar difficulty in reading the text: common, general taxonomic, and specific names are intermingled; thus, rat, oyster, and *Tenebrio molitor*. The important and extensive studies of the biochemistry of lower forms of animal life by Florkin and co-workers are discussed briefly in relation to the author's views on biochemical evolution. These studies could provide the material for a monograph apart from their relation to evolution. The reviewer suggests that this would have been of more interest as the present volume contains little about biochemical evolution that has not been expressed better by previous writers.

C. R. Treadwell

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Climatic accidents in landscape making: a sequel to "Landscape as developed by the processes of normal erosion." (2nd printing.) C. A. Cotton. New York: John Wiley, 1948. Pp. xx + 354. (Illustrated.) $7.00.

This is the second printing of a book issued in 1942. It is in part a sequel to the author's *Landscape*, which treats of land forms developed by common processes in humid climates. This volume deals with "interruptions" in "normal" geomorphic cycles.

Section I discusses dry and dry-seasonal climatic landscape types. It includes eolian erosion, arid erosion cycle, the cycle under semi-arid conditions, piedmont slopes and lateral planation, sheetflood erosion, the cycle of desert mountains, savana landscapes and inselbergs, and sand dunes. The reviewer does not consider these forms to be climatic accidents in a strict sense but rather results of specific climatic conditions, as "normal" as those resultant from humid climates.

Section II is a treatment of the salient features of glaciated landscapes. It treats of glaciers (in a brief and somewhat elementary fashion), glacial erosion (rather briefly), the manifold land forms resulting from glacier

erosion (in considerable detail), the doctrine of glacial protection, and the constructional forms. In a long range geologic view these are climatic accidents, although scarcely more so than some other geomorphic phenomena which are not repeated with any great regularity. The discussion of erosional features produced by alpine glaciers is excellent and stimulating.

The illustrations, both text diagrams and photographs, are notable in their clarity and pertinence.

The author's effort has been successful in assembling and interpreting a vast amount of geomorphic data in two climatic environments, and in its synthesis into a coherent and interesting picture of land forms in arid and glacial climates. This is a book that should be on the reading shelf of all geomorphologists, geographers, and others interested in these climatic factors.

ARTHUR BEVAN

Illinois Geological Survey

Advances in protein chemistry. (Vol. IV.) M. L. Anson and John T. Edsall. (Eds.) New York: Academic Press, 1948. Pp. ix + 575. (Illustrated.) $8.50.

The eight reviews and essays in this volume deal with an interesting variety of themes bearing on the properties of proteins and amino acids.

In "Protein Gels," John D. Ferry surveys developments of the past few years, mainly on gelatin and fibrin gels, and provides a valuable discussion of the phenomenon of protein gelation. In "The Interactions of Proteins and Synthetic Detergents," Frank W. Putnam considers, in addition to the qualitative effects of surface active compounds on proteins and biological systems, evidence as to the mechanism of such interactions—binding via electrostatic forces, and the complex formation aided and stabilized by van der Waals' forces between nonpolar groups. "Proteins of Pathogenic Bacteria," by A. M. Pappenheimer, Jr., presents a brief but stimulating discussion of bacterial proteins (particularly from group A hemolytic streptococci), exotoxins and toxic enzymes, and methods for their extraction.

Alexander B. Gutman, in "The Plasma Proteins in Disease," furnishes a much needed review of a highly complicated subject. The critical discussion of methods, results, and their interpretations will be appreciated by the thoughtful reader. "Preparative Electrophoresis and Ionophoresis," by Harry Svensson, offers brief technical discussions of apparatus (compartment type and moving boundary) for the electrical fractionation of crystalloids and colloids. A. Neuberger, in "Stereochemistry of Amino Acids," gives well-organized discussions of the configuration of the amino acids, reactions involving substitutions on the α-carbon atom, catalytic racemization, and the occurrence of D-amino acids and their derivatives in nature. "X-Ray Studies of Amino Acids and Peptides," by Robert B. Corey, presents the results of diffraction studies on the atomic positions in crystals of diketopiperazine, glycine, DL-alanine and β-glycylglycine, and inferences therefrom as to the structures of and intermolecular forces in crystalline proteins. "Heme Proteins," by Jeffries Wyman, Jr., is an extensive survey "designed to bring out the beautiful interdependence of structure and function in the heme proteins, and in particular the balance between the character of the heme, the character of the protein, and the nature of the heme-protein linkage, in determining the properties of the molecule."

BARNETT COHEN

Johns Hopkins School of Medicine

Scientific Book Register

AMIS, EDWARD S. *Kinetics of chemical change in solution.* New York: Macmillan, 1949. Pp. ix + 332. (Illustrated.) $5.00.

ARNOW, L. EARLE. *Introduction to physiological and pathological chemistry.* (3rd ed.) St. Louis: C. V. Mosby, 1949. Pp. 595. (Illustrated.) $4.00.

BALDWIN, ERNEST. *An introduction to comparative biochemistry.* (3rd ed.) Cambridge, Engl.: Univ. Press; New York: Macmillan, 1948. Pp. xiii + 164. (Illustrated.) $1.75.

MCNEMAR, QUINN. *Psychological statistics.* New York: John Wiley; London: Chapman & Hall, 1949. Pp. vii + 364. (Illustrated.) $4.50.

MOORE, RAYMOND CECIL. *Introduction to historical geology.* New York-London: McGraw-Hill, 1949. Pp. ix + 582. (Illustrated.) $5.00.

SCHENK, EDWARD T., and MCMASTERS, JOHN H. (Revised by KEEN, A. MYRA, and MULLER, SIEMON WILLIAM.) *Procedure in taxonomy: including a reprint of the International Rules of Zoological Nomenclature with summaries of opinions rendered to the present date.* (Rev. ed.) Stanford, Calif.: Stanford Univ. Press, 1948. Pp. vii + 93. $2.50.

TESCH, J. J. *The thecosomatous pteropods: the Indo-Pacific.* (Part II.) (The Carlsberg Foundation's Oceanographic Expedition Round the World 1928–30 and Previous "Dana" Expeditions, No. 30.) Copenhagen: C. A. Reitzels; London: Oxford Univ. Press, 1948. Pp. 45. (Illustrated.) 10/.

The measurement of stress and strain in solids: based on the proceedings of a conference arranged by the Manchester and District Branch of the Institute of Physics on 11, 12, and 13 July 1946. London: Institute of Physics, 1948. Pp. x + 114. (Illustrated.) $4.00.

————. *Jaarboek der Koninklijke Nederlandsche Akademie van Wetenschappen.* Amsterdam: N. V. Noord-Hollandsche Uitgevers Matschappij, 1948. Pp. 225. (Illustrated.)

NEWS and Notes

James Stevens Simmons, dean of the Harvard School of Public Health, has been appointed chairman of the Advisory Medical Board of the Leonard Wood Memorial (American Leprosy Foundation). Gen. Simmons was recently awarded the Legion of Honor by the French government in recognition of his service to France as chief of the Preventive Medicine Service for the U. S. Army.

Alexander M. MacKay, Canadian anesthetic specialist, has been appointed subchairman of the Department of Anesthesiology at the University of Wisconsin to succeed **Ralph Waters**, who retired last fall.

S. C. Ogburn, Jr. has been made a director of the Foote Mineral Company of Philadelphia, where he holds the position of manager of research and development.

Francis W. Dunmore, co-inventor with the late Harry Diamond of the blind landing system for aircraft retired from the staff of the National Bureau of Standards after 31 years of service.

Ralph W. Sockman, chaplain of New York University and pastor of Christ Church, Methodist, has been made director of the Hall of Fame for Great Americans to succeed the late James Rowland Angell.

Abbott Research Laboratories has announced three recent appointments: **Marlin T. Leffler** as assistant director of research, **Marvin A. Spielman** as head of the organic research department, and **Arthur W. Weston** as assistant head.

Hans Lowenbach, associate professor of neuropsychiatry at Duke University, has been called to active duty by the U. S. Army Medical Corps for a year's service in the European theater.

Carl L. Titus, former director of the Magnetic Recorder Division, Armour Research Foundation, Chicago, has been appointed assistant director of the Stanford (California) Research Institute, where he will be in charge of development and industrial service.

Isadore Levin, director of the Physical Medicine Department, Doctors Hospital, Washington, D. C., has been appointed an associate professor of medicine, in charge of the Department of Physical Medicine of the Georgetown University School of Medicine.

Hans Brattström, of Lund University, Sweden, has been appointed professor of zoology at the University of Bergen, Norway. Professor Brattström is at present studying the fauna of the Pacific along the south coast of Chile.

Stanley A. Cain, plant geographer at the Cranbrook Institute of Science, will attend the ninth International Phytogeographic Excursion in Ireland in July. He will also attend a conference at Trinity College, Dublin, on current problems in glacial history of northeastern Europe.

Earle K. Plyler, of the National Bureau of Standards' Radiometry Laboratory, has been appointed consultant to the Atomic Energy Commission at Oak Ridge, where he will act as advisor on molecular spectra and infrared spectrometry.

John O. Brew, lecturer on anthropology and director of the Peabody Museum, has been appointed Peabody Professor of American Archaeology at Harvard University.

James A. Shannon, director of the Squibb Institute for Medical Research, New Brunswick, New Jersey, has been appointed associate director of the National Heart Institute in charge of research.

Arthur J. Eames, professor of botany, Cornell University, has been appointed president of the Section of Morphology and Anatomy of the Seventh International Botanical Congress to be held in Stockholm next year.

Visitors to U. S.

James F. Danielli, English cancer specialist and honorary secretary of the British Biological Council, gave a series of lectures at the University of Chicago, April 27–29.

Hideki Yukawa, nuclear physicist of Kyoto University, Japan, has been named visiting professor of physics at Columbia University for the 1949–50 academic year. Professor Yukawa is presently engaged in research at the Institute for Advanced Study at Princeton.

A. M. J. F. Michels, of Van der Waals Laboratory, Amsterdam, presented a paper on high pressure as a tool in the study of molecular physics at the recent meeting of the American Physical Society, in Washington, D. C.

L. H. Gray, of the Radiotherapeutic Research Unit of the Medical Research Council, Hammersmith Hospital, London, spoke on the influence of morphology of the ionization tract on the biological effects of radiation, at the Argonne National Laboratory seminar held April 22. **Lars Melander**, of the Sweden Nobel Institute, Stockholm, was another recent visitor at Argonne.

Grants and Awards

Gilbert Grosvenor will be the first recipient of the National Geographic Society's newly established Grosvenor Medal. He will be given the medal May 19, on his 50th anniversary as editor-in-chief of the National Geographic magazine.

The U. S. Atomic Energy Commission will finance 21 new research programs in biology and medicine, under contract with 16 universities and two hospitals. Eleven of the contracts will be administered directly by the AEC; the remainder by the Office of Naval Research. The contracting institutions, administrative offices, project supervisors, and studies to be made are as follows:

Amherst College, ONR, *H. H. Plough*, research in radiobiology and chemical genetics; University of Cincinnati, ONR, *Robert Kehoe*,

studies on chronic berylliosis, tumor production by beryllium, and analytical methods; Columbia University, AEC, *S. C. Werner*, use of radioactive iodine in developing quantitative assay method for thyrotropic hormone; University of Delaware, ONR, *Mary A. Russell*, comparison of the effects of X-rays, neutrons, and mustard compounds on the growth and development of corn seedlings; University of Denver, ONR, *Fred E. D'Amour*, the physiologic and pathologic effects of radioactive cobalt; Duke University, ONR, *Philip Handler*, metabolic studies with radioactive isotopes; University of Florida, AEC, *A. A. Bless*, bioelectric potentials of plants and animals as a function of radiation injury; Henry Ford Hospital, Detroit, AEC, *F. W. Hartman*, survival of red blood cells after treatment with nitrogen mustard; Johns Hopkins University, AEC, *Abel Wolman*, proposed investigation of adsorption and assimilation of radioactive waste by bacterial slimes; University of Kansas, AEC, *E. R. Hall*, radium chloride and hemopoietic physiology of native rodents; Meharry Medical College, ONR, *Paul Hahn*, treatment of neoplasms; University of Michigan, ONR, *Fred J. Hodges*, radioautography; Mount Sinai Hospital, New York City, AEC, *R. Loevinger*, measurement of tissue dose due to gamma and beta active radioisotopes; University of North Carolina, AEC, *C. P. Van Cleave* and *C. T. Kaylor*, radioautographic study of beryllium 7; North Carolina State College (three contracts): (1) ONR, *J. A. Weybrew*, metabolism of copper; (2) AEC, *W. C. Gregory*, peanut seed irradiation; (3) AEC, *N. S. Hall*, movement of ions through soils systems; Purdue University, ONR, *Heinrich Koffler* and *P. A. Tetrault*, use of radioactive isotopes in studying mold metabolism, with emphasis on the assimilatory mechanisms of *Penicillium chrysogenum*; Washington University School of Medicine, ONR, *Wendell Scott*, experiments to determine the feasibility of developing equipment that will be capable of mapping the outlines of organs or deposits of metastatic tumor within the body; Yale University (two contracts): (1) AEC, *E. C. Pollard*, monomolecular layers of serological agents; (2) AEC, *E. C. Pollard*, irradiation of viruses and large molecules.

Vannevar Bush, president of the Carnegie Institution and wartime chairman of the Office of Scientific Research and Development, has been awarded the 1949 medal of the Industrial Research Institute for his coordination of industrial and academic research with the defense effort.

Fellowships

Massachusetts Institute of Technology's department of aeronautical engineering announces the following five graduate fellowships for 1949–50: **Richard C. du Pont Memorial Fellowships** in aeronautical engineering, for graduate students in any year of work toward an advanced degree, tuition plus $1200 single, $1800 married (two available). **Douglas Aircraft Company Fellowship**, for a graduate student, $1500 (one available). **Goodyear Tire and Rubber Company Fellowships** for graduate students, $1500 (two available). Further details may be obtained by writing Professor J. C. Hunsaker, Department of Aeronautical Engineering, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

The National Research Council announces the availability of 50 Atomic Energy Commission Technical Fellowships in Radiological Physics. These fellowships, which are administered by the NRC, are intended to develop a pool of trained individuals to meet the many needs of industrial laboratories, AEC plants, and hospitals. The primary requisites in the selection of the technical fellows is an undergraduate degree with a major in physics, chemistry, or engineering (usually electrical or chemical) with a minor in mathematics, biophysics, or similar fields; applicants with other qualifications may be considered in special cases. Applicants must be citizens of the U. S. under 35 years of age.

Fellows will probably be assigned for training to one of the AEC installations. The training programs may differ in detail among the training organizations, but will cover the general subjects of radiation measurements, industrial hygiene and toxicology, sanitary engineering, radiation biology, introduction to research, modern physics, nuclear physics, and mathematics. The annual basic stipend is $1,500 for a single fellow, and up to $2,500 for a married fellow. Tuition, fees, and travel expenses will be paid. Initial appointments will be for one year, and reappointment may be made upon application if warranted by the progress of the fellow. Applications will be acted upon in June, and only those applications completely documented by *June 10* will be considered by the NRC Fellowship Board at that time. The fellowships will begin at the start of the academic year 1949–50. Requests for application blanks or additional information should be addressed to the Fellowship Office, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

Colleges and Universities

Harvard University's School of Public Health has announced a new training program for cancer control officers, financed in part by grants from the U. S. Public Health Service and the Massachusetts Division of the American Cancer Society. The course is open to candidates for the degrees of Master of Public Health and Doctor of Public Health and provides training for doctors, statisticians, and health educators for participation in cancer control work. The program will be directed by Leonid S. Snegireff, associate professor of cancer control at the Harvard School of Public Health.

Summer Programs

San Francisco State College will hold a field school of natural history June 27–August 6 in Bixby Canyon, Monterey County, California. The course will offer firsthand field experience for students of college level, with emphasis on

he identification of plants and animals and their interrelationship with nonliving surroundings. Further information may be had by writing the Division of Natural Science, San Francisco State College, 124 Buchanan Street, San Francisco 2.

A new 6-month course in nuclear science will be given at **Reed College**, Portland, Oregon, under the sponsorship of the Atomic Energy Commission. It is designed to meet the needs of post-doctoral fellows under the AEC's Division of Biology and Medicine, but is open to other qualified persons. The summer session will be held July 5–September 10 and will include a review of physics and introduction to nuclear physics by Kenneth Davis, assistant professor of physics; a review of mathematical analysis and introduction to statistics by Robert A. Rosenbaum, associate professor of mathematics; and a review of the principles of chemistry by Arthur F. Scott, professor of chemistry, and Josef F. Bunnett and Arthur H. Livermore, assistant professors of chemistry. Information on the program may be obtained by writing the AEC Training Program, Reed College, Portland 2, Oregon.

A special summer course, Catalysis in Organic Chemistry, will be offered at the Ipatieff Catalysis Laboratory at **Northwestern University** by Herman Pines, of the Universal Oil Products Company. Inquiries should be addressed to R. K. Summerbell, Chairman, Department of Chemistry, Northwestern University, Evanston, Illinois.

The New England Association of Chemistry Teachers will hold its 11th summer conference August 22–27 at the University of New Hampshire, at Durham. Further information may be had by writing the conference secretary, Carl P. Swinnerton, Pomfret School, Pomfret, Connecticut.

The Second Annual Industrial Mycology Short Course will be held at **Purdue University** July 11–23. The course will include a series of evening lectures, a morning lecture-laboratory course in mold isolation and identification, and an afternoon course in physiology of the fungi. Further information may be obtained by writing to M. M. McClure, Division of Technical Extension, Purdue University, Lafayette, Indiana.

Industrial Laboratories

Vitamin B_{12}, the heretofore rare pernicious anemia specific, will now be available in large quantities, **E. R. Squibb and Sons** has announced. Members of the Squibb research staff have discovered that B_{12} can be obtained from streptomycin mold.

Calco Chemical Division, American Cyanamid Company, Bound Brook, New Jersey, has consolidated its research, process development, and dyes technical service into a new department, to be known as Research and Development Department. It will be headed by K. H. Klipstein. H. Z. Lecher has been named director of research in charge of chemical research.

Meetings and Elections

The Company Member Conference of the American Standards Associaton will meet May 19–20. The first day's session will be held at the Benjamin Franklin Hotel, Philadelphia and will be devoted to discussions on standardization, by which it is the aim of the conference to improve service to industry and the consumer. Frank P. Tisch, chief engineer of the Pheoll Manufacturing Company and vice chairman of the Sectional Committee on Screw Threads, will discuss the importance to American industry of the British-Canadian-U. S. agreement on unified screw threads (see *Science*, April 1, 346). A tour of the Princeton Laboratories of the Radio Corporation of America, where a number of recent electronic developments are now on trial, is planned for May 20. Colleges and industrial organizations in the Philadelphia area are invited to send representatives to the meeting.

The Inter-University High Altitude Laboratory will hold a cosmic ray symposium at Echo Lake, Colorado, June 22–28. The U. S. Atomic Energy Commission and the Office of Naval Research will be co-sponsors with the six cooperating universities —the University of Chicago, Cornell University, University of Denver, Massachusetts Institute of Technology, New York University, and Princeton University. Discussion meetings on radiation will be led by Marcel Schein, those on properties of mesons by Carl D. Anderson, on nuclear interactions of cosmic rays by Bruno Rossi, and on showers by Hans Bethe and Kenneth Greisen. About 60 participants have been invited, and scientists who are not issued invitations may attend. Further details may be obtained from Byron E. Cohn, Department of Physics, University of Denver, Denver 10, Colorado.

The International Union of Chemistry will hold its 15th conference in Amsterdam September 6–10. Official U. S. delegates will be Roger Adams, University of Illinois; Ralph Connor, Rohm and Haas Company; Warren C. Johnson, University of Chicago; H. F. Mark, Polytechnic Institute of Brooklyn; Emil Ott, Hercules Powder Company; and Edward Wichers, National Bureau of Standards. W. Albert Noyes, Jr., chairman of the NRC Division of Chemistry and Chemical Technology, and vice president of the IUC, will also attend.

The National Academy of Sciences, at its annual meeting in Washington April 25–27, elected as vice president for a four-year term beginning July 1 Edwin Bidwell Wilson, professor emeritus of vital statistics, Harvard School of Public Health. (The other Academy officers are: president, Alfred N. Richards; foreign secretary, Detlev W. Bronk; home secretary, Fred E. Wright; treasurer, William J. Robbins.) Chosen as council members for a three-year term ending June 30, 1952, were: Joel H. Hildebrand, professor of chemistry, University of California at Berkeley; and Ernest W. Goodpasture, professor of pathology and dean of the School of Medicine, Vanderbilt University. (Other council members are: Alfred N. Richards, Edwin B. Wilson, Detlev W. Bronk, Fred E. Wright, William J. Robbins, Carl R. Moore,

W. Albert Noyes, Jr., J. Robert Oppenheimer, and Donald D. Van Slyke.)

Newly elected Academy members are: George W. Bartelmez, professor of anatomy, University of Chicago; Frank A. Beach, professor of psychology, Yale University; Robert B. Brode, professor of physics, University of California at Berkeley; Paul R. Burkholder, Eaton Professor of Botany, Yale University; Lowell T. Coggeshall, professor and chairman, Department of Medicine, and dean, Division of Biological Sciences, University of Chicago; Max Delbrück, professor of biophysics, California Institute of Technology; Robert C. Elderfield, professor of chemistry, Coumbia University; William F. Gibbs, vice president, Gibbs and Cox, New York City; William W. Hansen, professor of physics, Stanford University; Charles B. Huggins, professor of surgery, University of Chicago; Walter D. Lambert, U. S. Coast and Geodetic Survey (retired); Howard B. Lewis, professor and head of Department of Physiological chemistry, University of Michigan; Francis W. Loomis, professor and head of Department of Physics, University of IIllinois; Thomas S. Lovering, U. S. Geological Survey; Samuel M. McElvain, professor of chemistry, University of Wisconsin; Saunders MacLane, professor of mathematics, University of Chicago; Nicholas U. Mayall, Lick Observatory; Otto Meyerhoff, research professor of physiological chemistry, University of Pennsylvania; John S. Nicholas, Sterling professor of biology, Yale University; George B. Pegram, professor of physics and dean of graduate faculties, Columbia University; Kenneth S. Pitzer, professor of chemistry, University of California at Berkeley; Kenneth B. Raper, senior microbiologist, Northern Regional Research Laboratory, U. S. Department of Agriculture; John L. Savage, chief designer, U. S. Bureau of Reclamation, Denver; Carl F. Schmidt, professor of pharmacology, University of Pennsylvania; Julian Schwinger, professor of physics, Harvard University; Harry L. Shapiro, professor of anthropology, Columbia University; Oliver R. Wulf, professor, Division of Chemistry and Chemical Engineering, California Institute of Technology; Ralph W. G. Wyckoff, scientist director, National Institutes of Health; Frederick W. H. Zachariasen, professor and chairman of the Department of Physics, University of Chicago.

Six new foreign associates were elected by the Academy: Elie Cartan, professor of geometry, University of Paris; Paul A. M. Dirac, Lucasian professor of mathematical physics, St. John's College, Cambridge, England; Bernard Lyot, astronomer, Meudon Observatory, Seine-et-Oise, France; Henri Piéron, director, Laboratory of Physiological Psychology, The Sorbonne, Paris; Arne Tiselius, professor of biochemistry, University of Upsala, Upsala, Sweden; Öjvind Winge, director, Department of Physiology, Carlsberg Laboratory, Copenhagen (Valby).

The first branch of **RESA, the Scientific Research Society of America,** was installed at the Esso Research Club of the Standard Oil Company (New Jersey) in Linden, New Jersey, April 20. More than 300 research men, visiting scientists, and officials of the company were present. The afternoon program included an inspection trip of the laboratories of the new Esso Research Center, recently dedicated, and of the Bayway Refinery. The installation address on "Fuels and the Internal Combustion Engines of the Future" was given by Charles F. Kettering, of General Motors Corporation.

NRC News

The National Research Council has announced the awarding of the RCA Predoctoral Fellowships in Electronics to eight graduate students. The awards are supported by the Radio Corporation of America, and the selection of fellows was made by the RCA Fellowship Board of the National Research Council.

The newly appointed fellows and their fields of research are: *Charles K. Birdsall*, Stanford University, interaction of electric fields and electron streams; *David Carter*, Stanford University, electron bunching by means of electromagnetic waves; *William A. Craven, Jr.*, Princeton University, microwave techniques including generation, amplification, and transmission; *Gerald Estrin*, University of Wisconsin, microwave propagation and field theory; *Fumio Bob Naka*, Harvard University, focal properties of cathode-ray guns and illuminators; and *Howard C. Poulter*, Stanford University, interaction of electromagnetic waves and electron streams and its use in new types of vacuum tubes. Fellows whose awards have been renewed for another year are: *Arthur L. Aden*, Harvard University, for work in electromagnetic engineering and allied fields, with possible applications to meteorology; and *Robert W. Olthuis*, University of Michigan, for work in low pressure gas discharge applications at microwave frequencies.

The NRC has also announced ten awards of the Merck Postdoctoral Fellowships in the Natural Sciences. These fellowships are supported by Merck and Company, Inc., and the selection of fellows was made by the Merck Fellowship Board of the National Research Council.

The new appointees and their research topics are: *Melvin Cohn*, Pasteur Institute, Paris, biochemistry, immunochemistry, and enzymology, especially adaptive enzymes of bacteria; *Ruth Sager*, Rockefeller Institute for Medical Research, genetics: gene actions, gene and cytoplasm relations, cytoplasmic inheritance; *Robert C. C. St. George, Jr.*, California Institute of Technology, biological chemistry: cellular physiology with some emphasis on the chemistry of vision; *Edward C. Taylor, Jr.*, Laboratorium fur Organische Chemie, Zurich, stereochemistry of the pentacyclic triterpenes of the β-amyrin type. Fellows whose grants have been renewed, and their fields of work, are: *David H. Brown*, Washington University Medical School, synthesis and properties of compounds of biological interest; *Malcolm Gordon*, California Institute of Technology, intermediary metabolism; *Caspar W. Hiatt, 3rd*, Rockefeller Institute for Medical Research, chemical factors of natural immunity and the physical chemistry of proteins; *R. W.*

Lumry, Jr., University of Utah Medical School, enzyme kinetics as related to protein structure; *Clement L. Markert*, California Institute of Technology, embryology; and *Gunther S. Stent*, California Institute of Technology, physical chemistry, structure of high polymers, biophysics, bacterial viruses.

Deaths

W. Halsey Barker, 42, assistant dean of the Johns Hopkins University School of Medicine, died March 26 at Johns Hopkins Hospital, where he had been a patient for two months.

Jonas Borak, 56, Viennese radiologist who came to New York City ten years ago as a refugee, died April 4 of a heart ailment while lecturing at the New York Academy of Medicine.

Alphonse A. Thibaudeau, 64, head pathologist at the New York State Institute for the Study of Malignant Diseases, and former instructor in bacteriology at the University of Buffalo, died at his home in Buffalo April 6 following a brief illness.

Irving Hotchkiss Pardee, 57, neurologist at the Neurological Institute, Presbyterian Hospital, and at St. Luke's Hospital, New York City, and professor of neurology at Columbia University, died April 10 after a brief illness.

Whitman Cross, 94, geologist and authority on rose culture, died April 20 at Rockville, Maryland, after an illness of five years. Dr. Cross had been head of the U. S. Geological Survey for 37 years when he retired in 1925.

Catherine V. Beers, 57, associate professor of zoology at the University of Southern California, died April 22. Dr. Beers had done considerable work in genetics.

Sir Robert Robertson, 80, British chemist and director of the Salters Institute of Industrial Chemistry since 1937, died April 28 in London, after a brief illness. Sir Robert directed explosives research at Woolwich Arsenal during both world wars.

William H. Bauer and Irwin Gordon, Rutgers University ceramists, recently announced the successful **synthesis of single crystals of mullite,** a silicate rarely found in nature but occurring in the firing of certain ceramic materials. A new approach to silicate technology is suggested with the possibility of synthesizing commercially important silicates such as tourmaline, used in sonic detectors and electrical frequency controls.

The Federation of American Scientists, at its annual council meeting in Washington April 30–May 1, issued the following statement on National Science Foundation legislation:

"During the recently concluded hearings on National Science Foundation legislation before the House Committee on Interstate and Foreign Commerce, strong opposition to the entire Foundation concept was voiced by the National Patent Council. It appears that this organization has succeeded in arousing unfounded fears among small manufacturers and business men that the Foundation 'would inevitably dry up the creative fountainheads of American industry by stifling individual incentive to invent and produce.' In recent weeks Congressmen have had a steady flow of mail urging this point of view. The majority of the committee now considering the legislation is not likely to be impressed, since they have given sufficient study to the bills to recognize the falsity of the charges. But other Congressmen, who will make the final decision on the House floor, may be impressed if their mail continues to be predominantly opposed to the bill.

"The great majority of scientists, whatever the disagreements on detail, favor the establishment of a National Science Foundation. The long course of the legislation can be finally and successfully ended in the next month. It must not be jeopardized by silence on the part of scientists, silence which will be interpreted as indifference. The Federation of American Scientists calls upon all scientists and their organizations, recognizing that this is the critical hour for establishment of a National Science Foundation, to communicate directly with their own representatives in Congress urging them to vote for the National Science Foundation Act of 1949 when it reaches the floor of the House."

The newly elected officers of the federation are: Hugh C. Wolfe, associate professor of physics at the College of the City of New York and president of the federation's New York chapter in 1947–48, chairman; Clifford Grobstein, biologist at the National Cancer Institute, vice chairman; and Gerhart Friedlander, chemist at Brookhaven National Laboratory, secretary-treasurer.

The ornithological life of the Arctic area 200 miles south of the north magnetic pole will be studied this summer by the government-sponsored Perry River Expedition, which is to leave Edmonton, Alberta on May 17. The team of three scientists includes an Englishman—Peter Markhan Scott, waterfowl painter and director of the Seven Wild Fowl Trust—and two representatives of the U. S. Fish and Wildlife Service—Paul Queneau, research ornithologist of Westport, Connecticut and Harold C. Hanson, of the Illinois Natural History Survey. They will observe the flora and fauna of the region and make an intensive study of five fowl, the American brant, the black brant, the Ross goose, the tule goose, and the white-fronted goose. The team will be joined by Eskimo guides at Victoria Island in the Arctic and will mush 150 miles with dog sleds across the ice. James Bell, Canadian bush pilot, will join the expedition in July, when the thaw permits him to land his small plane.

An association for mutual information on blood groups has been proposed by P. H. Andresen, chief of the Serological Department, University Institute of Legal Medicine, Copenhagen, Denmark, with the aim of making new developments in this field more readily available to individual research workers. All researchers engaged in blood group work are invited to join. Inquiries may be sent to Dr. P. H. Andresen, Frederik Vs Vej 9, Copenhagen, Denmark. Members will receive *Blood Group News*, a monthly bibliography on blood group work. A limited

number of copies will be on sale by Ejnar Munksgaard, Copenhagen.

F. Firbas, Botanische Anstalten der Universität, Göttingen, Germany, has reported that the systematic-plant geography library of the University was completely destroyed during the war. He would be very grateful for any reprints in those fields that *Science* readers might send him.

The Association of American Medical Colleges recently announced the opening of its **Medical Film Institute,** with offices in the Academy of Medicine Building, 2 East 103rd Street, New York City. The MFI will function as an advisory body, providing producers and sponsors of medical films with an authoritative opinion as to the scientific, educational, and cinematic qualities of a proposed film. The Department of State has commissioned the MFI to select a group of the newest and best medical films for presentation abroad as part of the U. S. Information Service film program.

The Advisory Committee, headed by Walter A. Bloedorn, dean of George Washington University's School of Medicine, includes Francis Keppel, dean of Harvard's Graduate School of Education; Robert V. Schultz, chief of the Audio-Visual Training Section of the Navy Bureau of Medicine and Surgery; Orville Goldner, former head of Navy Training Films; and William A. Benedict, chairman of the American Medical Association's Committee on Medical Motion Pictures.

A new periodical, ***Physiologia Plantarium,*** covering all branches of plant physiology, is being published quarterly, as the official publication of the Scandinavian Society for Plant Physiology. The papers are printed in either English, French, or German. Nonmembers of the society may place subscription orders with Einar Munksgaard, Norregade 6, Copenhagen, Denmark or through local booksellers, but only members may submit contributions.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, lists the following wanted chemicals: indican, 5-keto-D-gluconic acid, tri-(p-isocyanatophenyl)methane, hemocyanin, 2,2'-dihydroxyazobenzene-3-sulfonic acid, 3,6,2',4'-tetrahydroxyflavone, 1-hydroxyphenazine, 1-hydroxyacridine, 1-hydroxy-2-anthramine, pyrographitic oxide, phthionic acid, 8-nitro-1-naphthoic acid, coriamyrtin, n-(β-diethylaminoethyl)phenothiazine, L-lyxose, 9-methyl-2,6,7-trihydroxy-3-fluorone, phenylpantothenone, monodeuteroethylene, hexafluorobutadiene, and 2-hydroxy-1-anthramine.

Make Plans for—

Society for Applied Spectroscopy, symposium, Brooklyn Polytechnic Institute, May 21, Brooklyn.

Canadian Psychological Association, May 26–28, Mount Royal Hotel, Montreal.

American Medical Association, annual session, June 6–10, Atlantic City, New Jersey.

Symposium on Fine Particles and Resolutions, June 9–10, Stevens Hotel, Chicago.

American Society of Electroencephalography, June 11–12, Chalfonte-Haddon Hall Hotel, Atlantic City, New Jersey.

International Conference on Science Abstracting, June 20–25, Unesco House, Paris, France.

1st International Congress of Biochemistry, August 19–25, Cambridge, England.

4th International Conference of the International Association of Quaternary Research, August 22–September 15, Budapest, Hungary.

Recently Received—

News from Unesco. A fortnightly publication from the Bureau of Public Information, Unesco, 19 Avenue Kléber, Paris 16, France.

The behavior of rocks and rock masses in relation to military geology, by Wilmot R. McCutchen. (Quarterly of the Colorado School of Mines, Vol. 44, No. 1). Single copies obtainable from the Colorado School of Mines, Golden, Colorado, at $1.00 each.

Technical & Scientific Cooperation: Projects Coordinated by the Interdepartmental Committee on Scientific and Cultural Cooperation in 1948. Issued in February 1949 by the Office of Public Affairs, Department of State, Washington, D. C.

Sugar and Sugar By-Products in the Plastics Industry by Louis Long. Technological Report Series No. 5. Available at no charge from the Sugar Research Foundation, Inc., 52 Wall Street, New York 5, N. Y.

Papers on the Soviet Genetics Controversy. Occasional Pamphlet No. 9 of the Society for Freedom in Science. Copies obtainable from the Assistant Secretary, Society for Freedom in Science, Dept. of Zoology, University Museum, Oxford, England at 1/3.

Story of Vitamin B_{12} by Ruth Woods. In *Borden's Review of Nutrition Research,* Vol. X, No. 1. The Borden Company, 350 Madison Avenue, New York 17, N. Y.

Immigrant Plants in the Hawaiian Islands, II, by F. Raymond Fosberg. Occasional Paper 46, University of Hawaii, Honolulu, Hawaii.

Importance of Upwelling Water to Vertebrate Paleontology and Oil Geology by Margaretha Brongersma-Sanders. Tweede Sectie, Deel XLV, No. 4. Koninklijke Akademie van Wetenschappen, Amsterdam (C.), Holland.

Fifth Semiannual Report of the Atomic Energy Commission, January 1949. U. S. Government Printing Office, Washington, D. C.

Abridged Scientific Publications from the Kodak Research Laboratories, Vol. XXIX, 1947. Eastman Kodak Company, Rochester, New York.

National Health Council, Annual Report, March 25, 1949. Prepared by National Health Council, 1790 Broadway, New York 19, N. Y.

Service, a monthly publication of Cities Service Company, 703 Ring Building, Washington 6, D. C.